NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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**June 5, 1968**



# PRELAUNCH MEASURED WINDS AND A COMPARISON OF THE EFFECTS OF PRELAUNCH AND STATISTICAL WINDS ON MODE I ABORTS FROM A SATURN IB LAUNCH VEHICLE

By Dallas G. Ives and Samuel R. Newman,
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MISSION PLANNING AND ANALYSIS DIVISION

MANNED SPACECRAFT CENTER
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PROJECT APOLLO

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John P. Mayer, Chief
Mission Planning and Analysis Division

FIGURES

# PRELAUNCH MEASURED WINDS AND A COMPARISON OF THE EFFECTS OF PRELAUNCH AND STATISTICAL WINDS ON MODE I ABORTS FROM A SATURN IB LAUNCH VEHICLE

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## SUMMARY

Prelaunch measured winds for Mercury, Gemini, and Apollo missions and the effect of these winds on mode I launch escape vehicle (LEV) aborts from a Saturn IB launch vehicle have been analyzed to evaluate the land landing problem. The effects of the prelaunch-measured winds are compared to those of statistical winds.

The probability of a land landing for mode I (LEV) aborts using actual prelaunch-measured winds is considerably less than that of studies based on statistical winds. All the abort landing points for the months of August and September were in water.

## INTRODUCTION

The analysis presented in this document was performed to:

1. Evaluate the velocity and azimuth of prelaunch-measured winds for all previous Mercury, Gemini, and Apollo misions and determine trends such as variations in high and low altitude winds for various times of day prior to launch.

2. Evaluate the effects of these prelaunch-measured winds on early mode I (LEV) abort landing points.

3. Compare the results of item 2 to the analysis of statistical winds presented in reference 1.

## ANALYSIS

### Wind Data

The prelaunch wind data used in this analysis are found in reference 2 for the Mercury missions, references 3 through 8 for the Gemini missions, and references 9 through 11 for the Apollo missions.

### Launch and Abort Data

The analysis was conducted utilizing the same LEV performance characteristics and LV operational flight trajectory used in reference 1, i.e., the one for the AS-204 mission. The analysis presented in reference 1 investigated the effect of statistical winds on mode I (LEV) abort landing points and showed that a high probability of land landing existed following a mode I (LEV) abort. The abort trajectories were generated from the nominal LV operational flight trajectory using the manual emergency detection system (EDS) limits of ±3deg/sec pitch and yaw body rates and $\pm 5^{0}$ pitch and yaw attitudes. These limits apply only to the first 50 seconds g.e.t. of the launch trajectory and define an abort footprint for each abort time. The maximum altitude experienced for a 50-second abort using the EDS limits and winds was approximately 25 000 feet.

## RESULTS

### Prelaunch Measured Winds

The prelaunch measured winds were evaluated and presented as velocity and azimuth as a function of altitude for various times prior to launch for each mission. Figure 1 presents the measured wind profile for the Mercury missions (MA-1 through MA-8), figure 2 presents the measured wind profile for the Gemini missions (GT-III through GT-XII), and figure 3 presents the measured wind profile for the Apollo missions (AS-201, AS-202 and Apollo 4).

The prelaunch measured winds presented in figures 1 through 3 indicate that, most of the time, the change in magnitude and direction of the early and late prelaunch measured winds (0 to 25 000-ft altitude) are negligible.

## Mode I (LEV) Abort Landing Points

Mode I (LEV) abort landing points were computed using measured prelaunch wind data from three each of the Mercury, Gemini, and Apollo missions. When there was more than one prelaunch wind measurement per mission, only the last measurement (the one closest to launch) is expressed in terms of the EDS limit abort footprint. The abort footprints computed for the no-winds case is presented in figure 4, and all have water landings.

Mercury missions.- Figure 5 presents mode I (LEV) abort landing points for MA-1 (July measured winds). There was a strong off-shore wind for MA-1; therefore, all of the abort footprints are in water. The abort landing points for MA-4 shifted offshore as the wind measurements approached lift-off time. The last wind measurement (lift-off minus 3 hours 4 minutes) showed all the abort footprints to be in the water. All abort landing points for MA-8 were in water.

Gemini missions.- Figure 6 presents mode I abort landing points for Gemini V (August measured winds), Gemini X (July measured winds), and Gemini XI (September measured winds). All abort landing points for Gemini V and XI are in water. The last wind measurement (lift-off minus 1 hour 30 minutes) for Gemini X shows the abort footprints shifting back over the beach; however, for the first 10 seconds g.e.t., the landing points are in water.

Apollo missions.- Figure 7 presents mode I abort landing points for AS-201 (February measured winds), AS-202 (August measured winds), and Apollo 4 (November measured winds). All of the abort landing points for AS-201 and AS-202 are in water. The measured wind (lift-off minus 1 hour) for Apollo 4 shows part of the 10-second abort footprint on land and all of the footprints through 40 seconds are on land.

## Comparison of Statistical and Measured Prelaunch Wind Data

Figure 8 presents mode I (LEV) aborts using statistical wind data. These figures were obtained from reference 1, so a direct comparison can be made between statistical wind effects and actual prelaunch measured wind effects on mode I (LEV) abort landing points. The statistical wind data in reference 1 were from rawinsonde observations taken twice daily over a period of 8 years (January 1, 1956, through December 31, 1963).

Figure 8(a) presents mode I abort footprints for July statistical winds. This plot shows that land landing exists and the abort footprints do not shift back over water until approximately 50 seconds of ground elapsed time. However, from figure 5(a) MA-1 (July measured winds) all of the abort footprints are in water. Also from figure 6(b) GT-X (July measured winds), the abort landing points for the lift-off minus 5 hours

20 minutes winds are all in water while the abort footprints for the lift-off minus 1 hour 30 minutes winds have land landing. Note that land landing does not occur until 30 seconds of ground elapsed time.

Figure 8(b) presents mode I abort footprints for August statistical winds and the footprints are over land from 20 seconds through 45 seconds g.e.t. However, from figure 6(a) GT-V (August measured winds) and figure 7(b) AS-202 (August measured winds) all of the abort landing points are in water.

Figure 8(c) presents mode I abort footprints for September statistical winds. This plot shows that land landing exists until after 60 seconds g.e.t. From figure 5(b) MA-4 (September measured winds) the abort landing points shifted offshore as the wind measurements approached lift-off time. The last wind measurement (lift-off minus 3 hours 4 minutes) showed all the abort footprints in water. Also, figure 6(c) GT-XI (September measured winds) shows all of the abort landing points in water.

## CONCLUSIONS

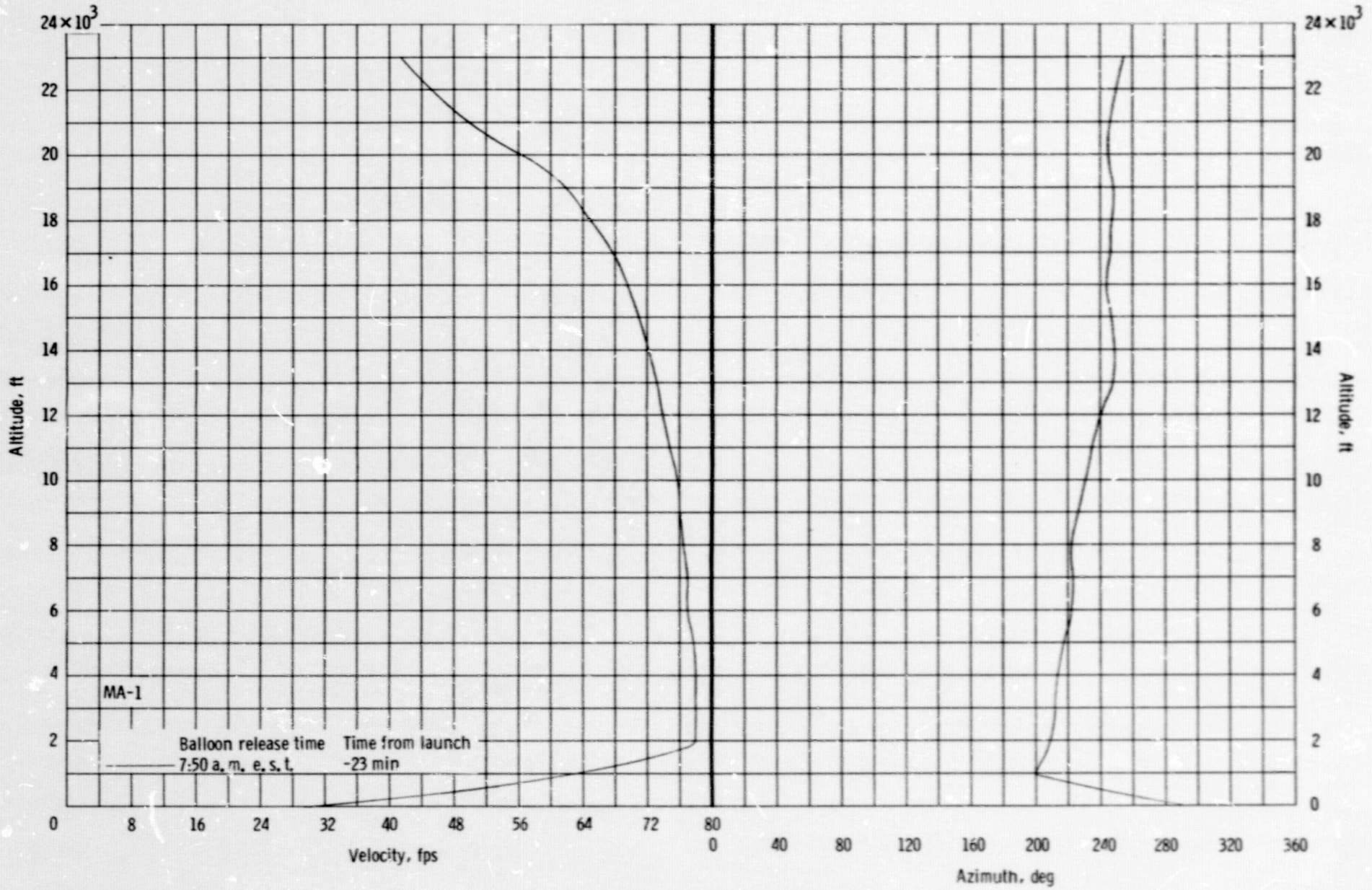
The conclusions from this analysis are:

1. The prelaunch measured winds from the Mercury, Gemini, and Apollo missions presented in this document indicate that most of the time the changes in magnitude and direction of the early (approximately T-7 hours) and late (approximately T-1 hour) winds from 0 to 25 000-ft altitude are negligible, and do not contribute significantly to any large dispersions in the abort landing points.

2. The probability of a land landing for mode I (LEV) aborts using actual prelaunch winds is greatly reduced compared to that of statistical winds.

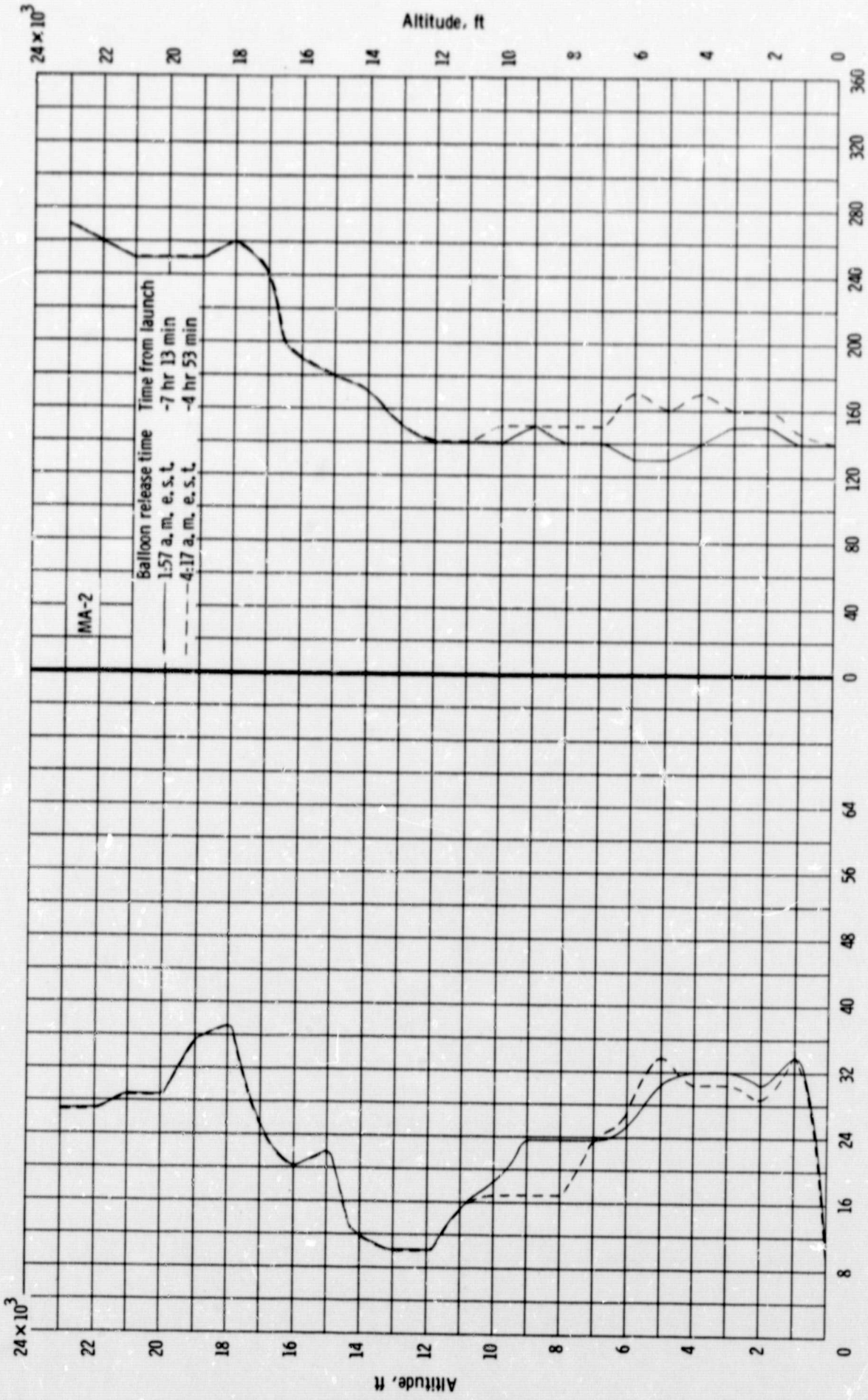
3. The statistical wind analysis (ref. 1) showed mode I (LEV) abort footprints on land for the months of August and September (worst wind month). However, the prelaunch measured winds considered in this analysis shows that no land landing existed for these 2 months.

The prelaunch winds will continue to be measured for each mission and input into the mode I (LEV) abort real-time prediction program to display the status of each of the abort landing points.



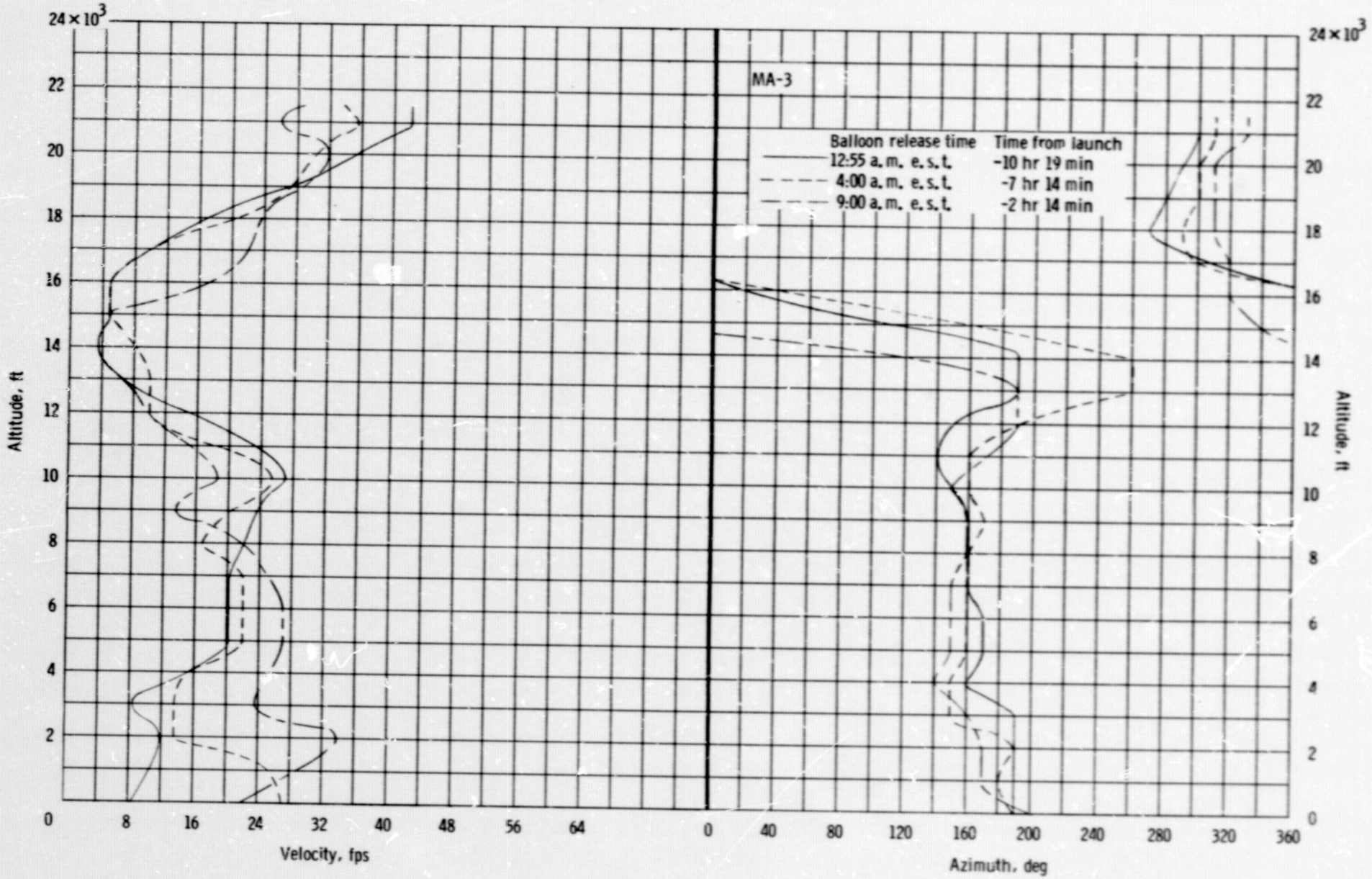

(a) MA-1 (July measured winds).

Figure 1. - Measured wind profile for the Mercury missions.



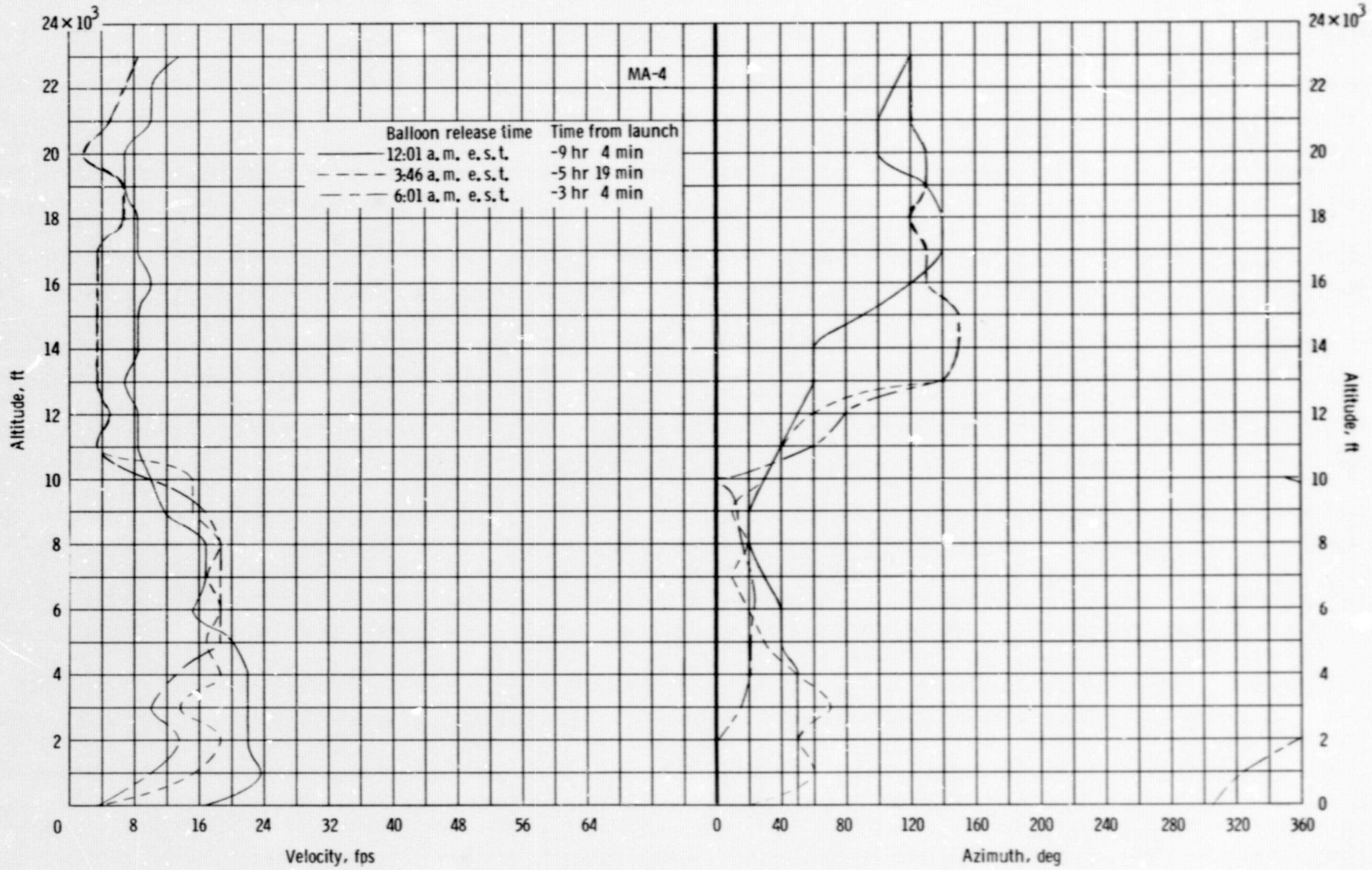

(b) MA-2 (February measured winds).

Figure 1. - Continued.



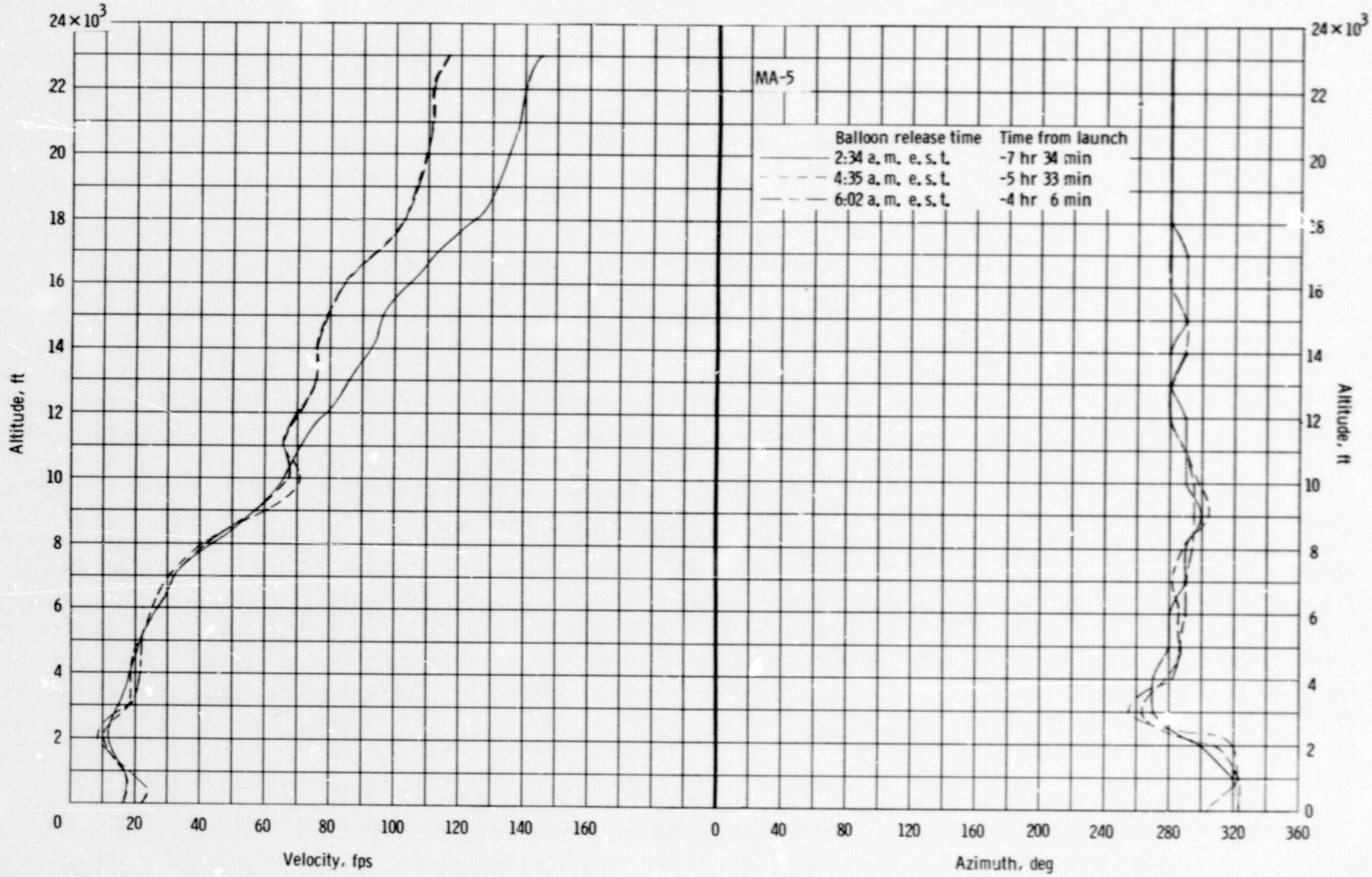

(c) MA-3 (April measured winds).

Figure 1.- Continued.



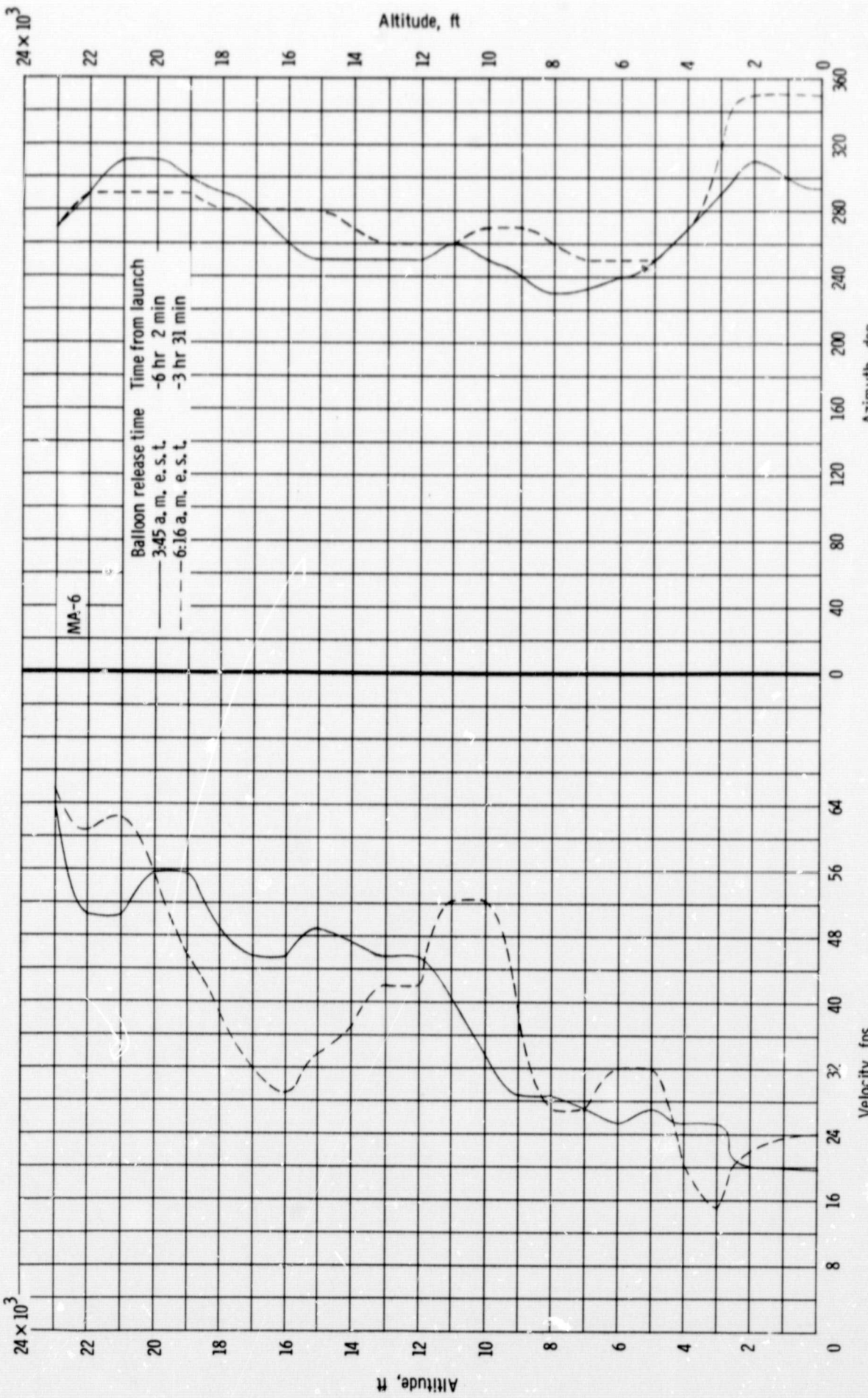

(d) MA-4 (September measured winds).

Figure 1. - Continued.



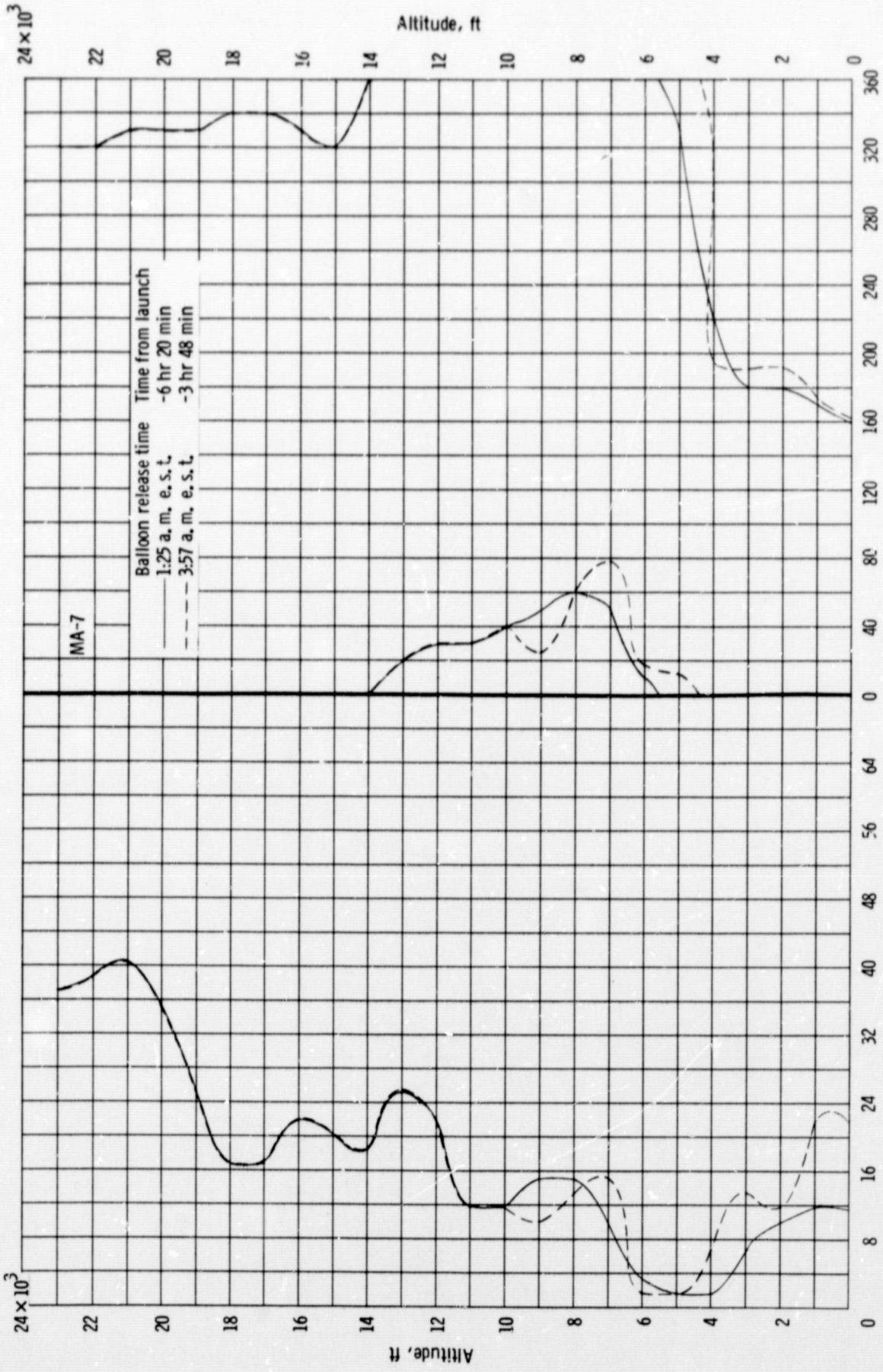

(e) MA-5 (November measured winds).

Figure 1. - Continued.



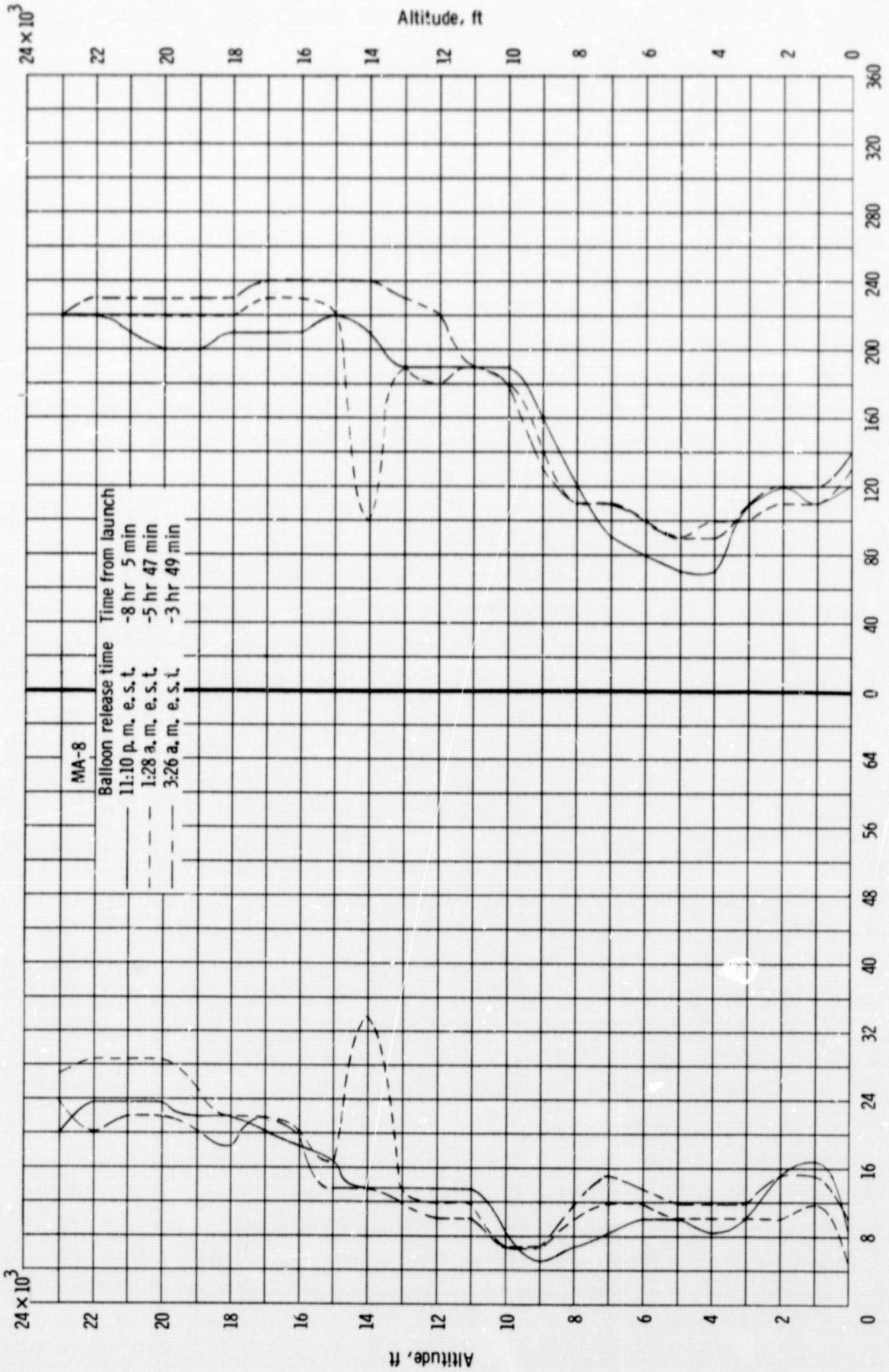

(f) MA-6 (February measured winds).

Figure 1.- Continued.



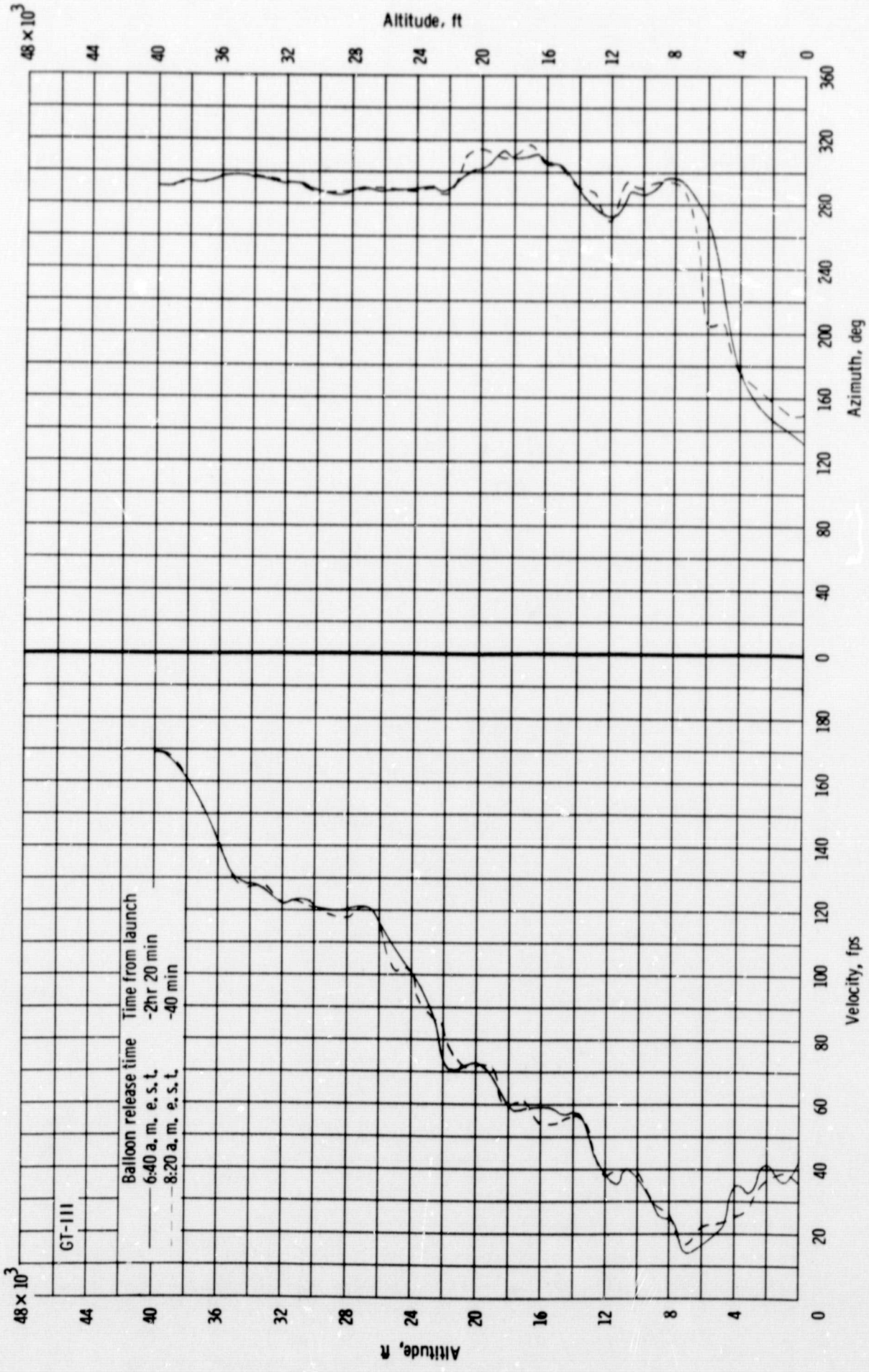

(g) MA-7 (May measured winds).

Figure 1. - Continued.



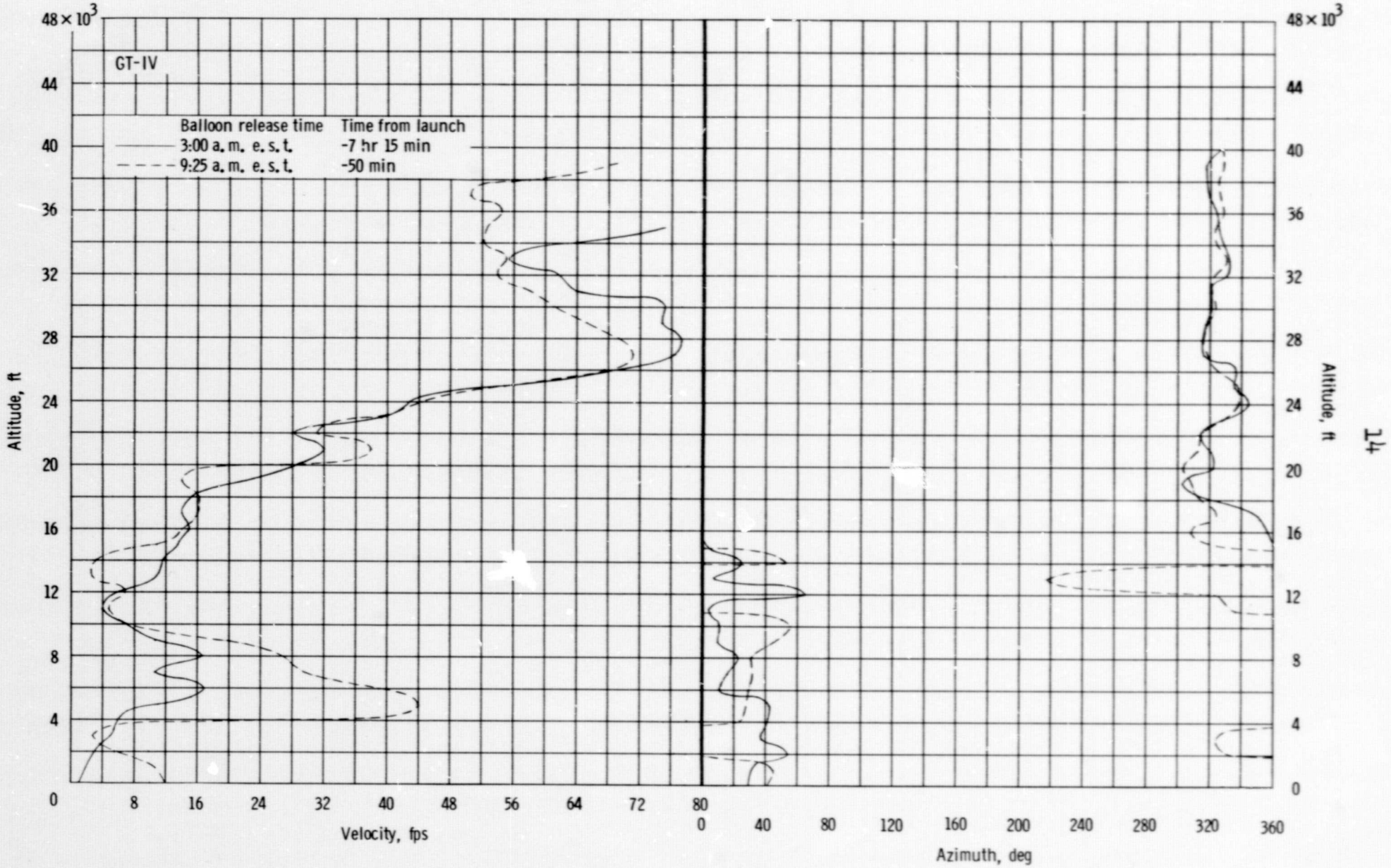

(h) MA-8 (October measured winds).

Figure 1. - Concluded.



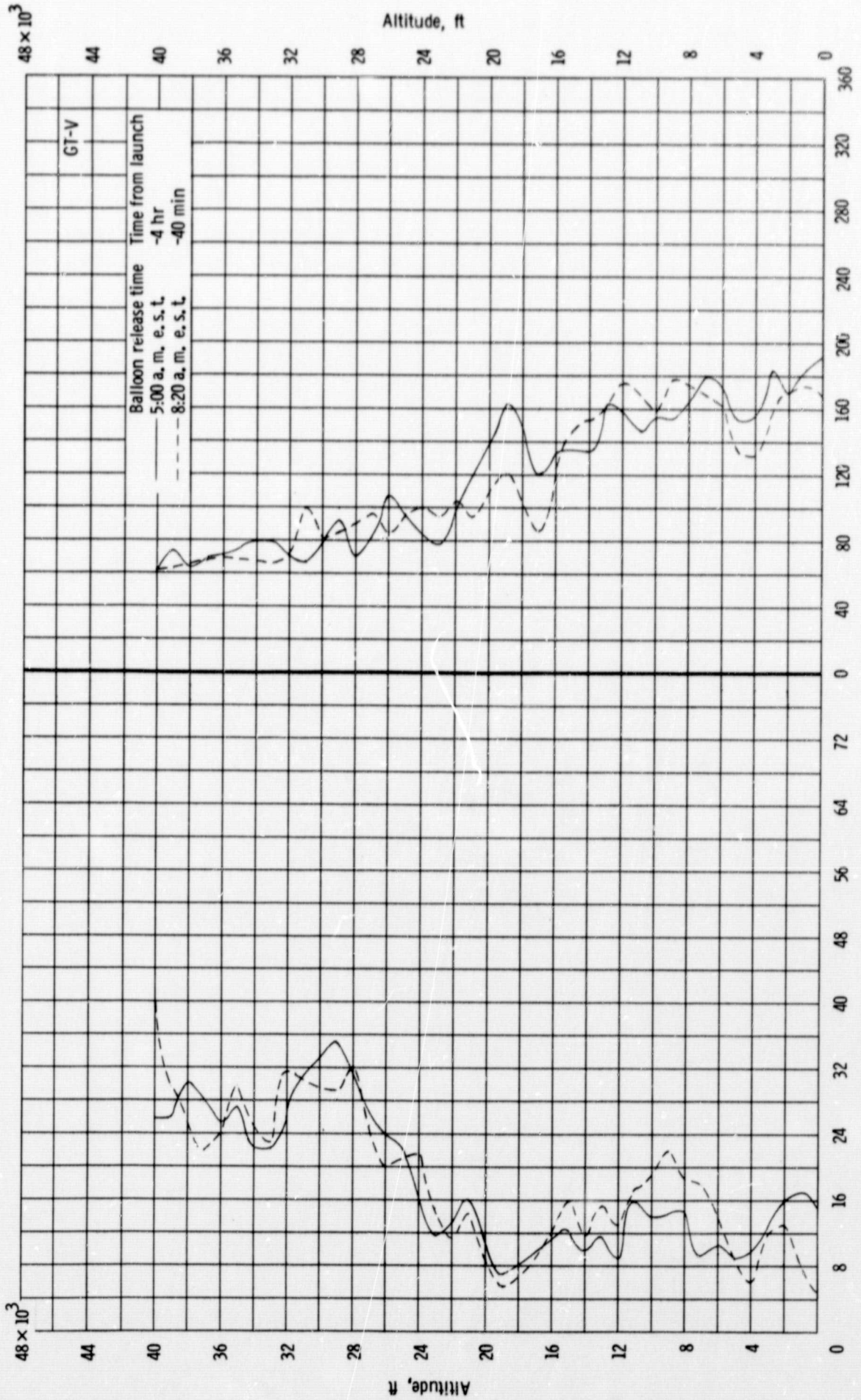

(a) GT-III (March measured winds).

Figure 2. - Measured wind profile for the Gemini missions.



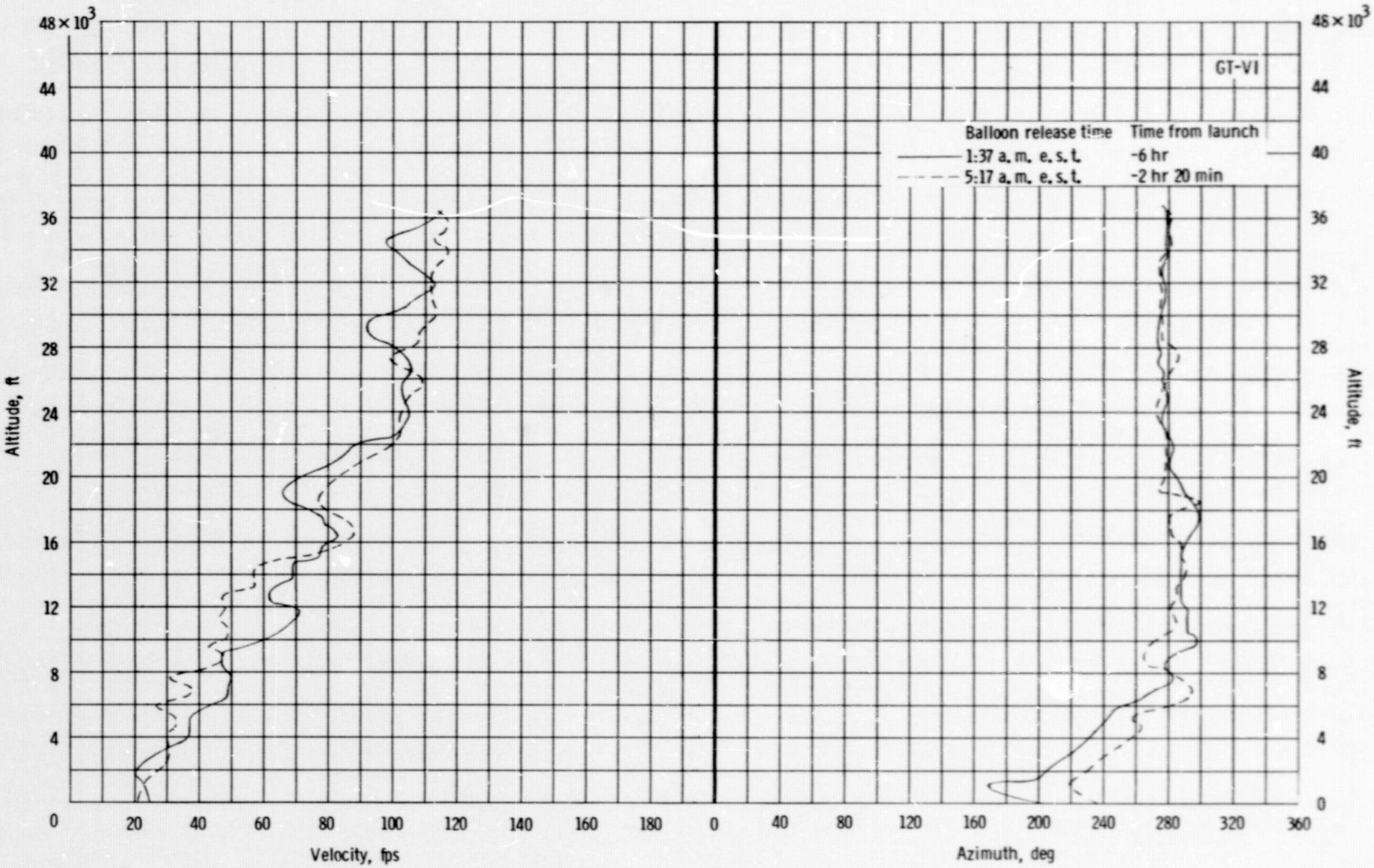

(b) GT-IV (June measured winds).

Figure 2. - Continued.



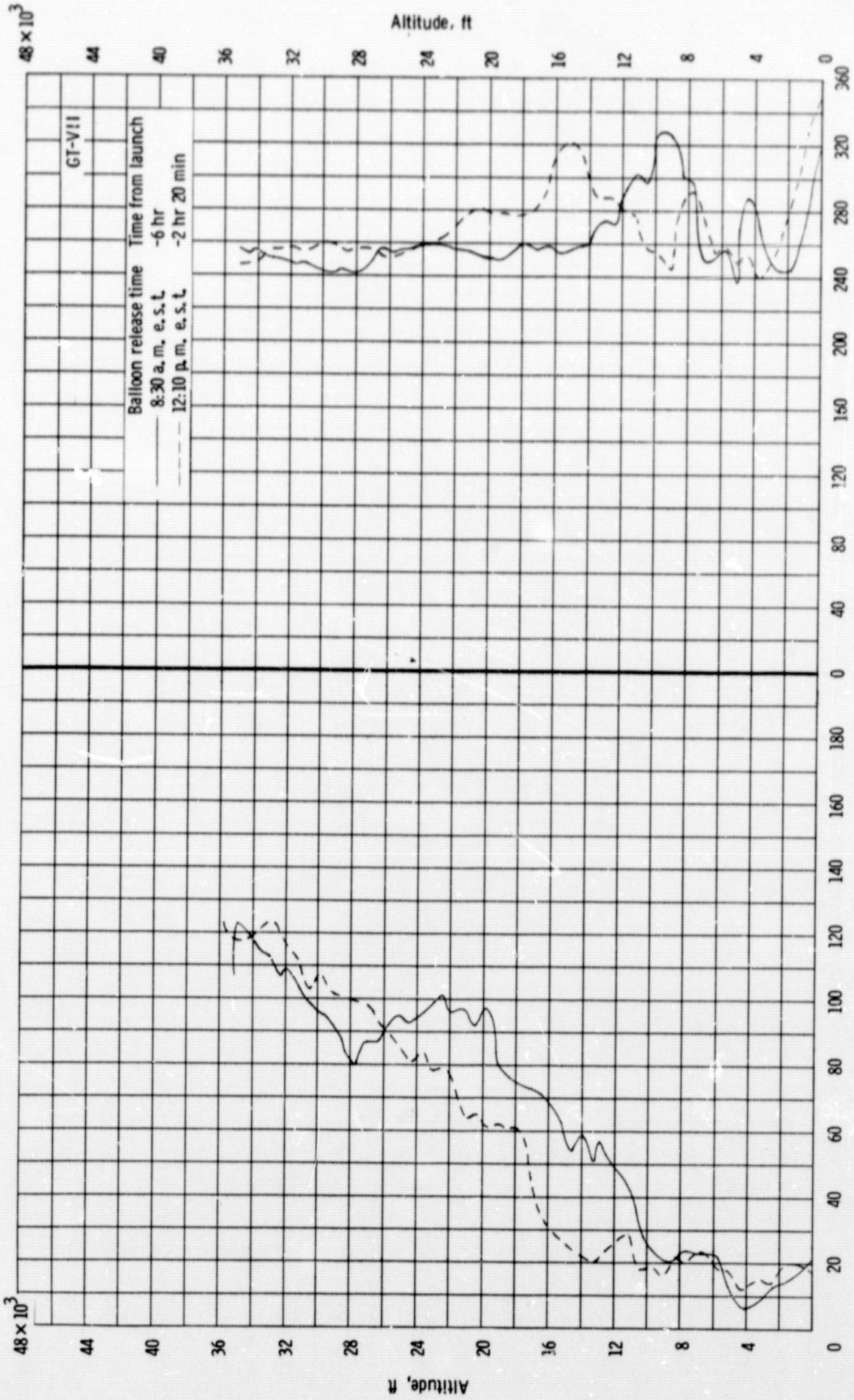

(c) GT-V (August measured winds).

Figure 2. - Continued.



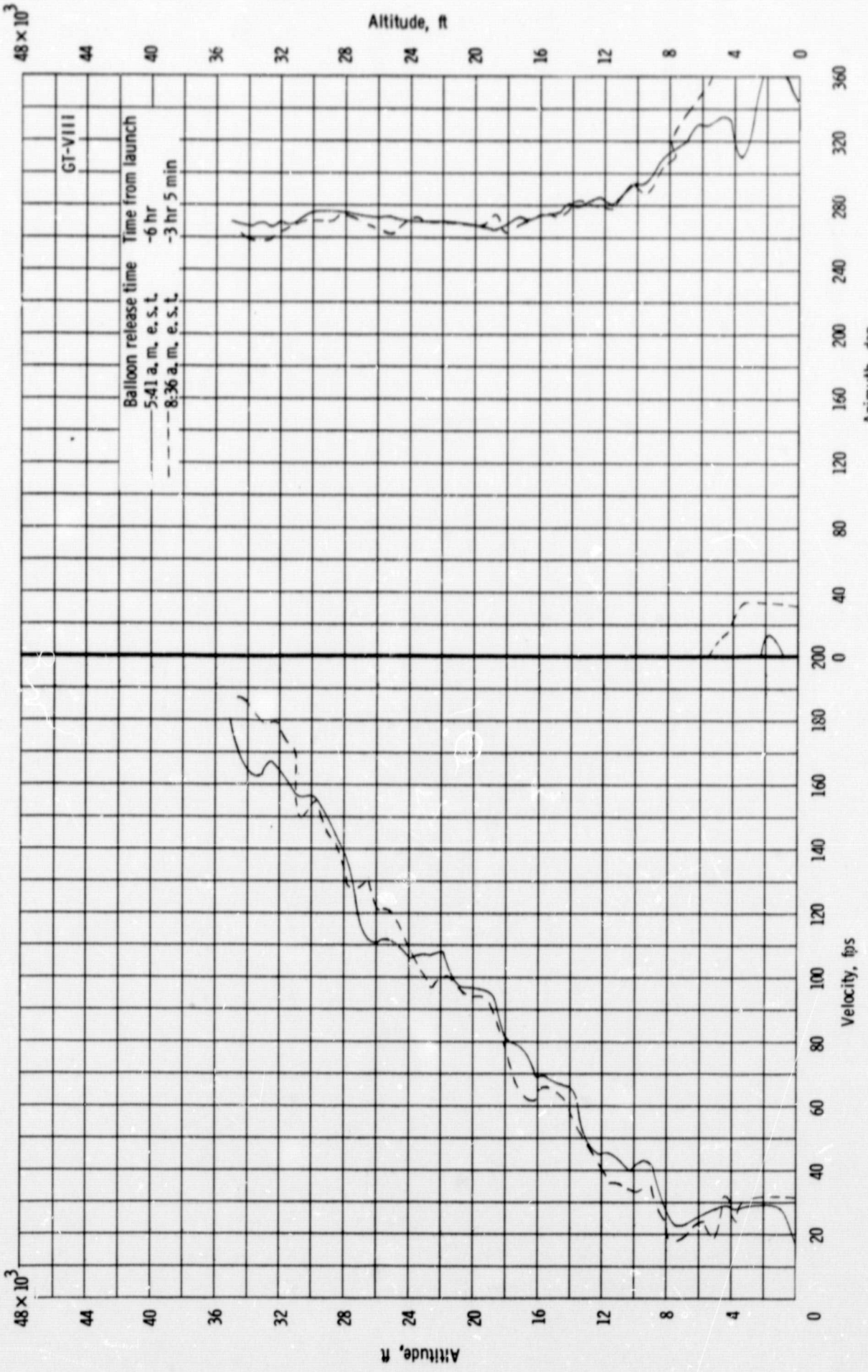

(d) GT-VI (December measured winds).

Figure 2. - Continued.



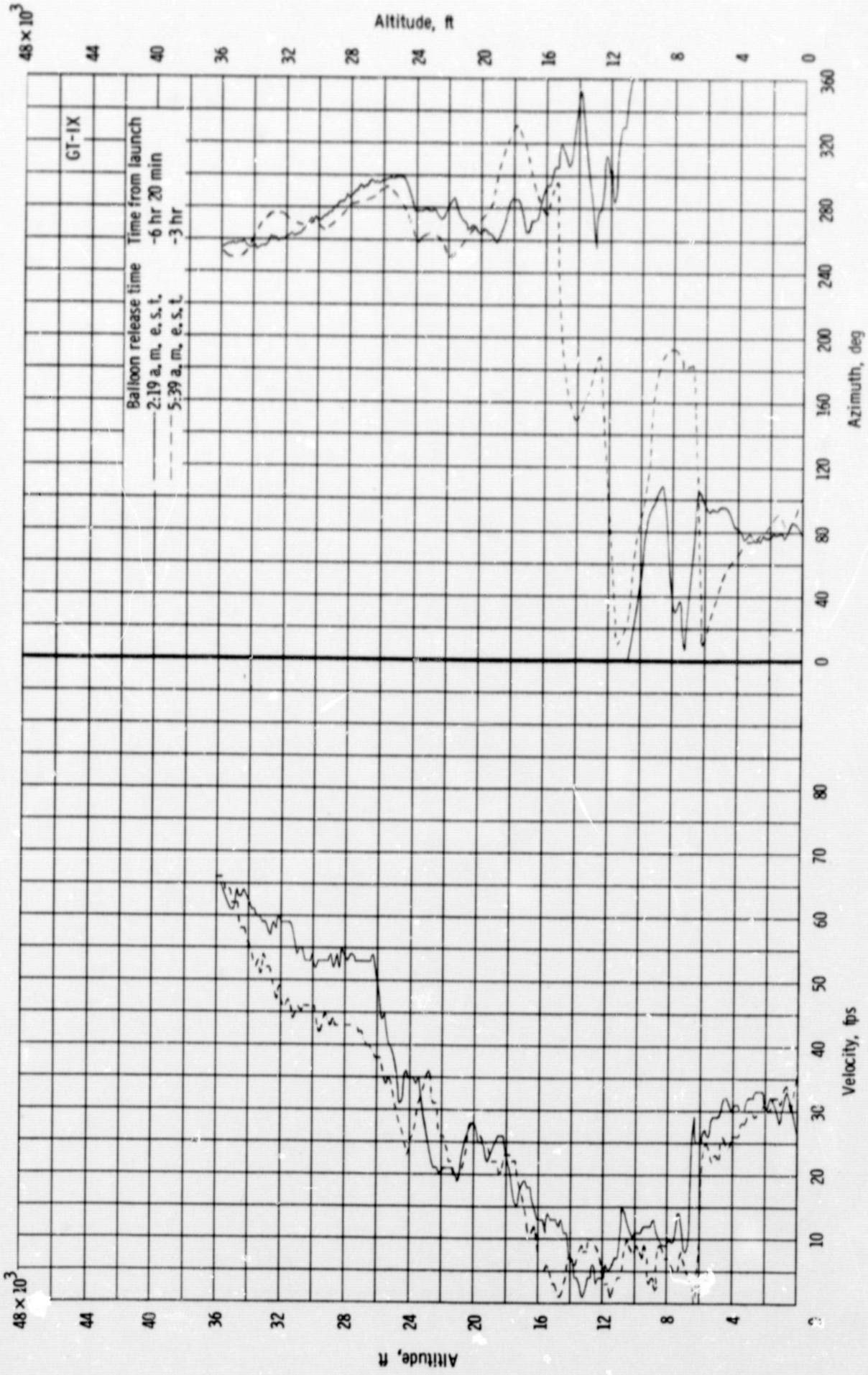

(e) GT-VII (December measured winds).

Figure 2.- Continued.



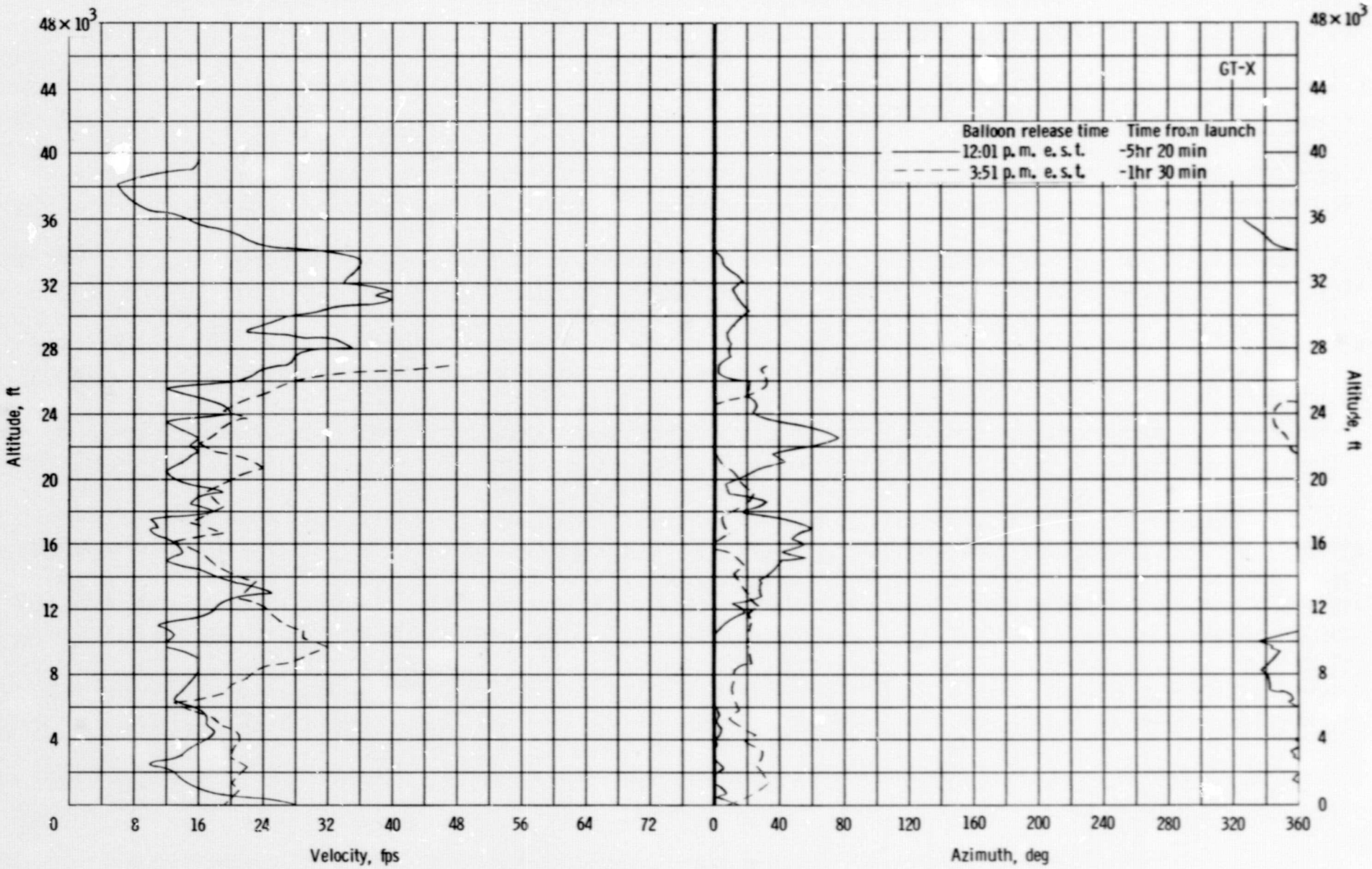

(f) GT-VIII (March measured winds).

Figure 2 - Continued.



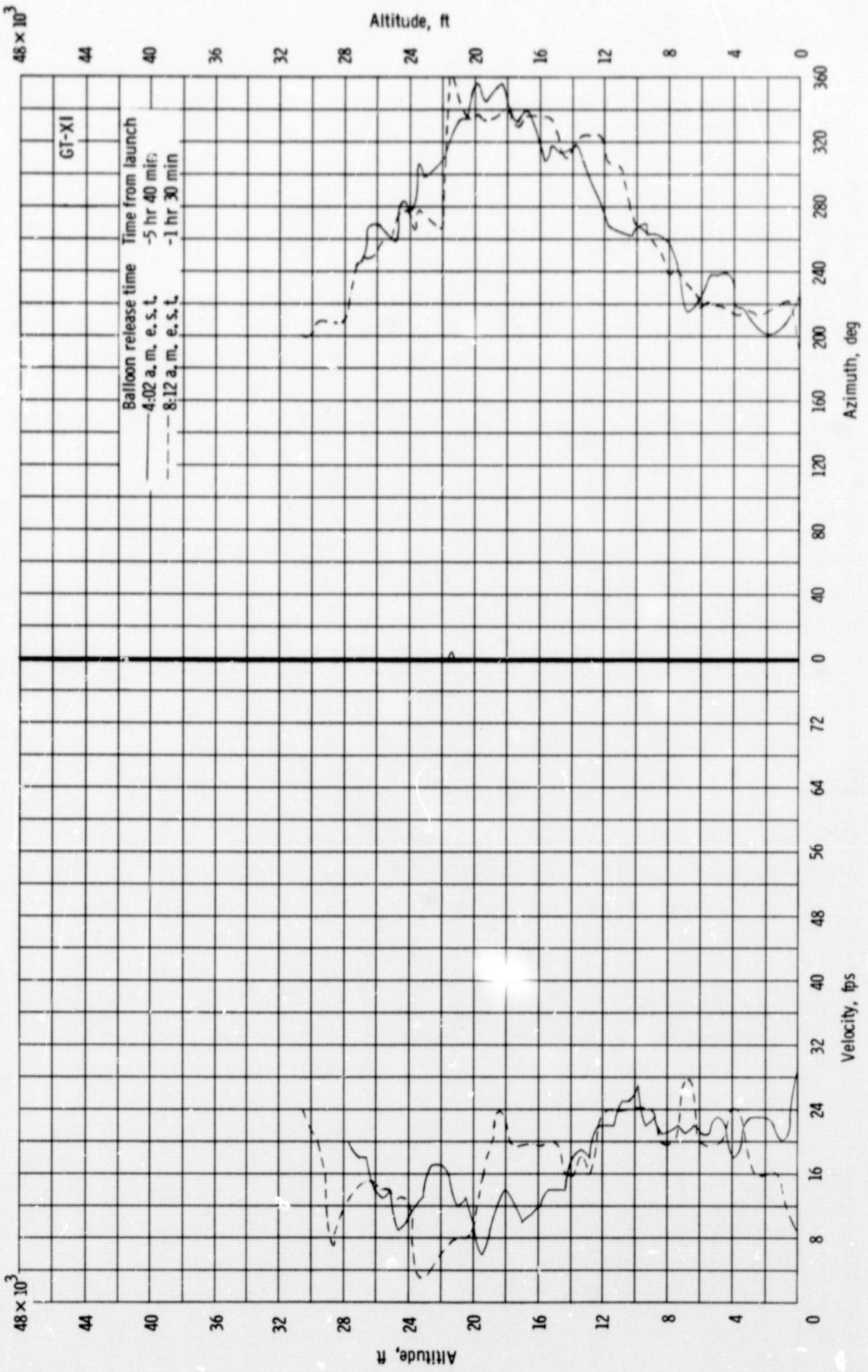

(g) GT-IX (June measured winds).

Figure 2 - Continued.



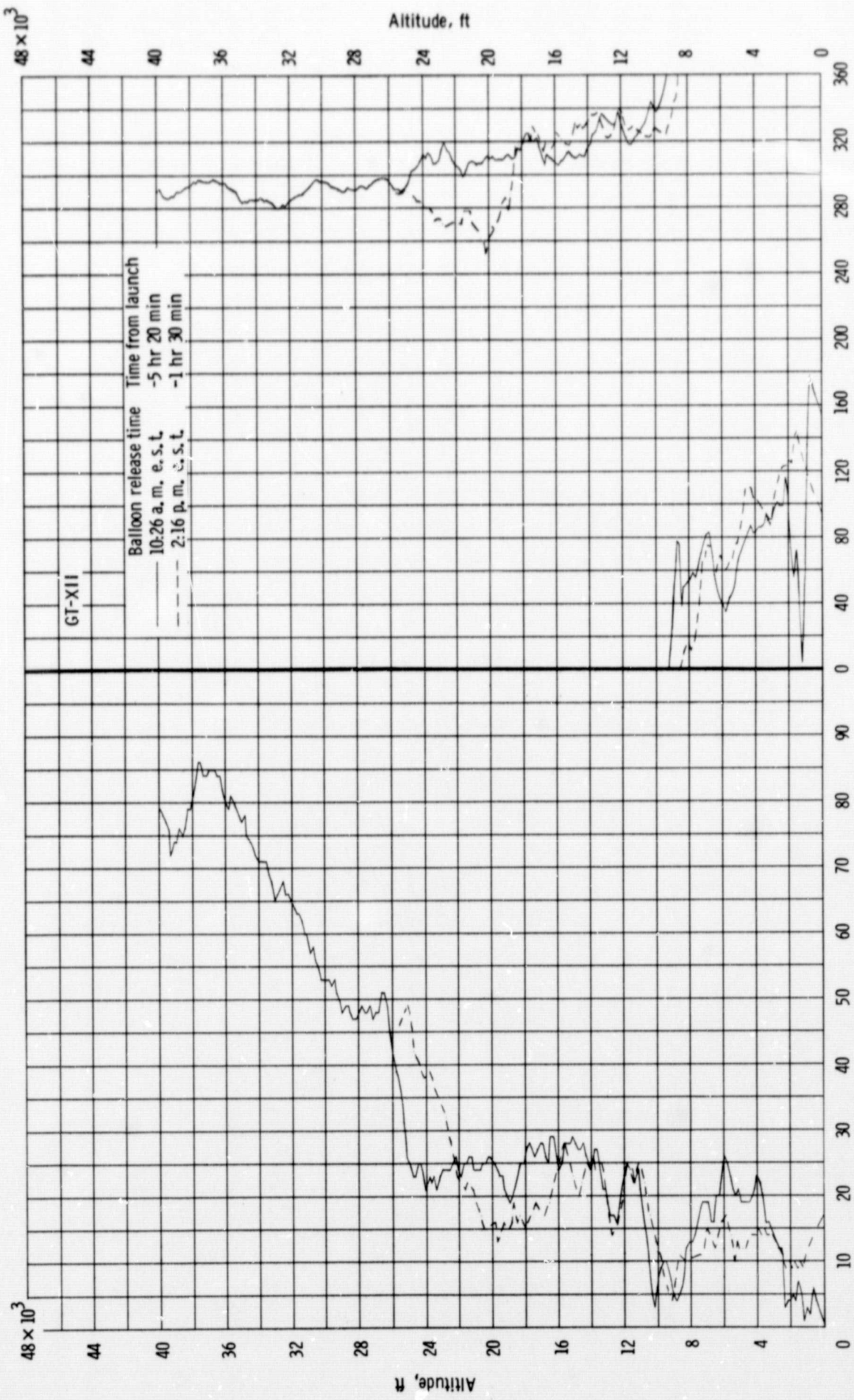

(h) GT-X (July measured winds).

Figure 2. - Continued.



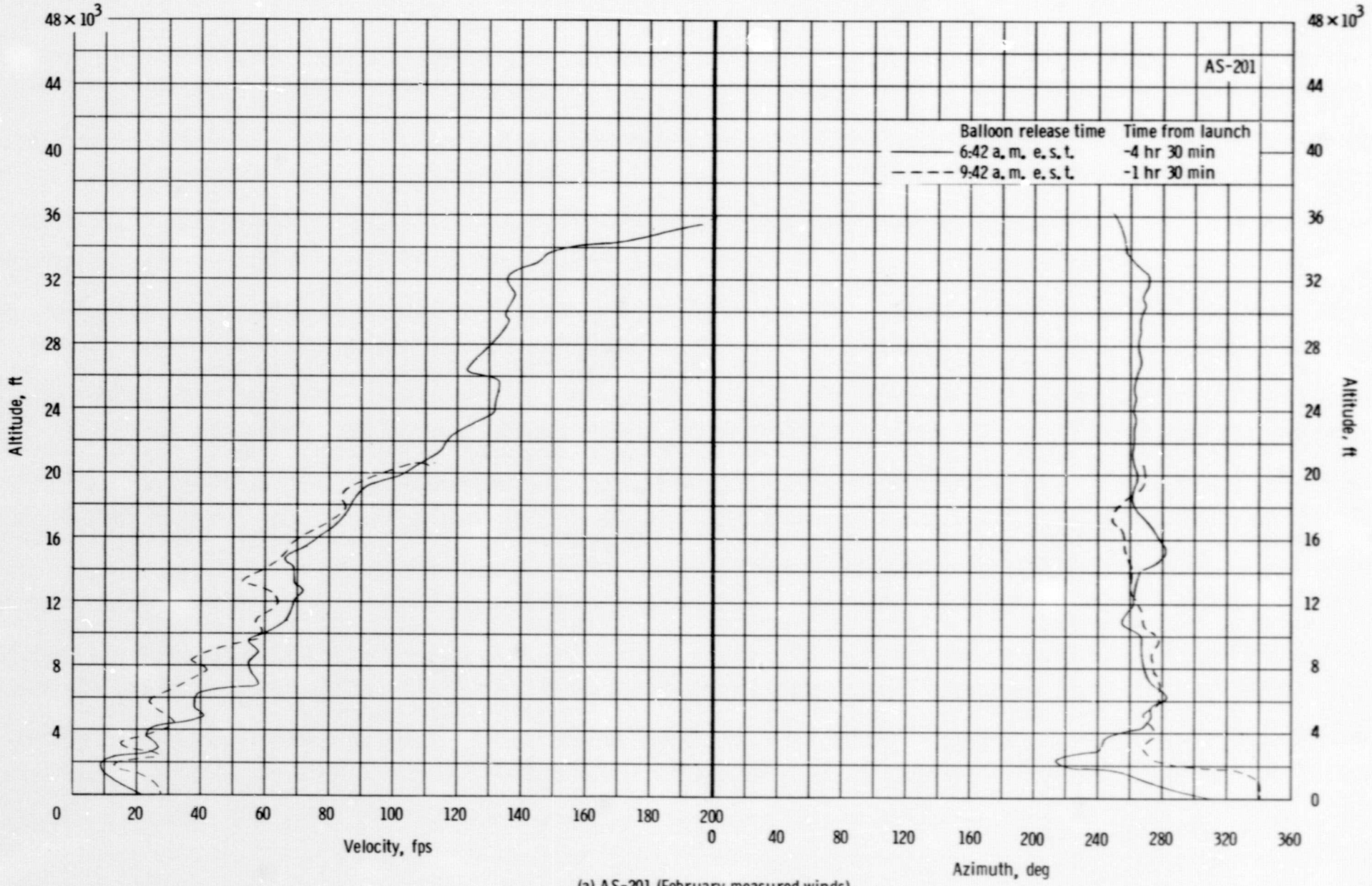

(i) GT-XI (September measured winds).

Figure 2. - Continued.



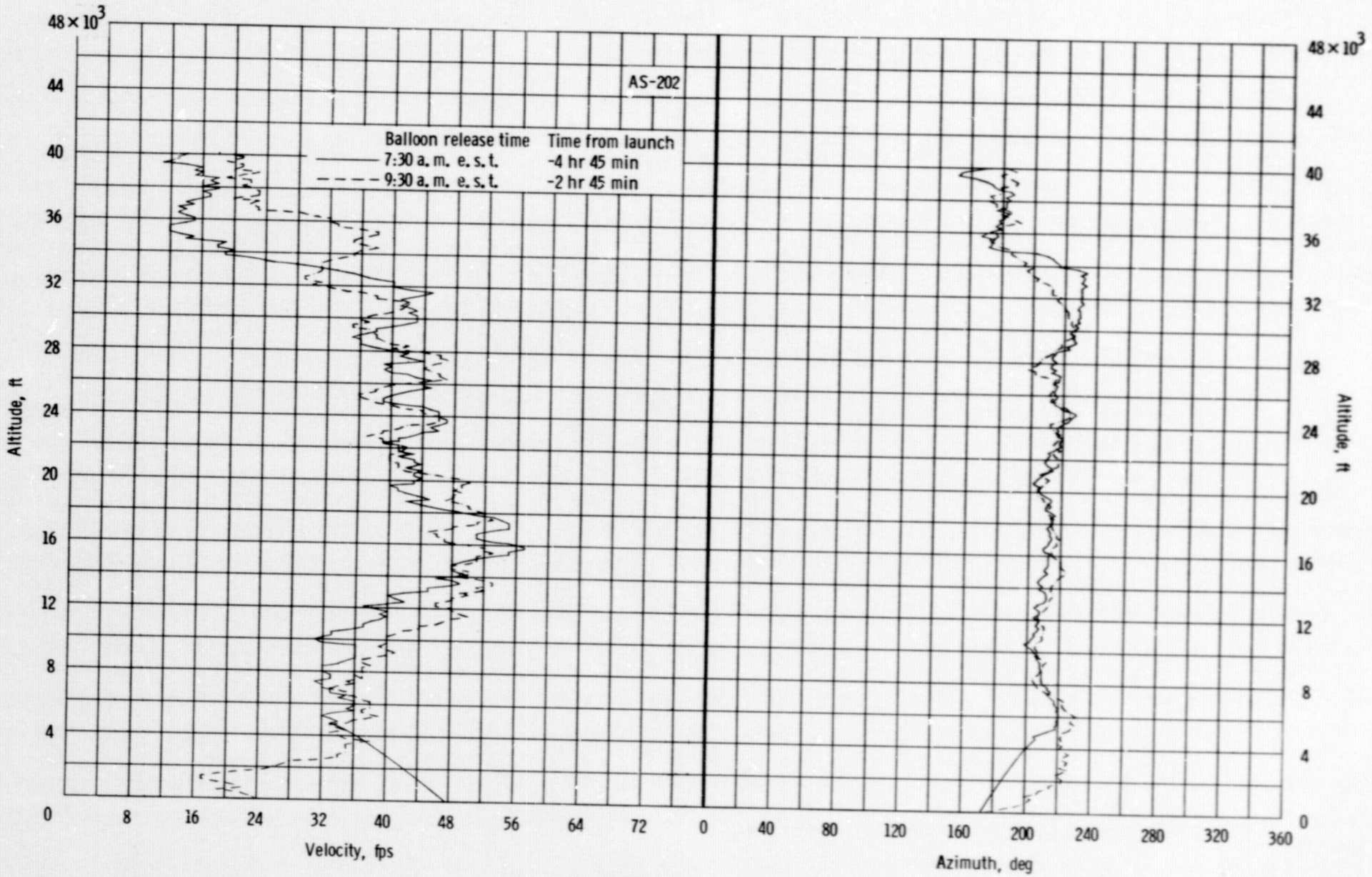

(j) GT-XII (November measured winds).

Figure 2. - Concluded.



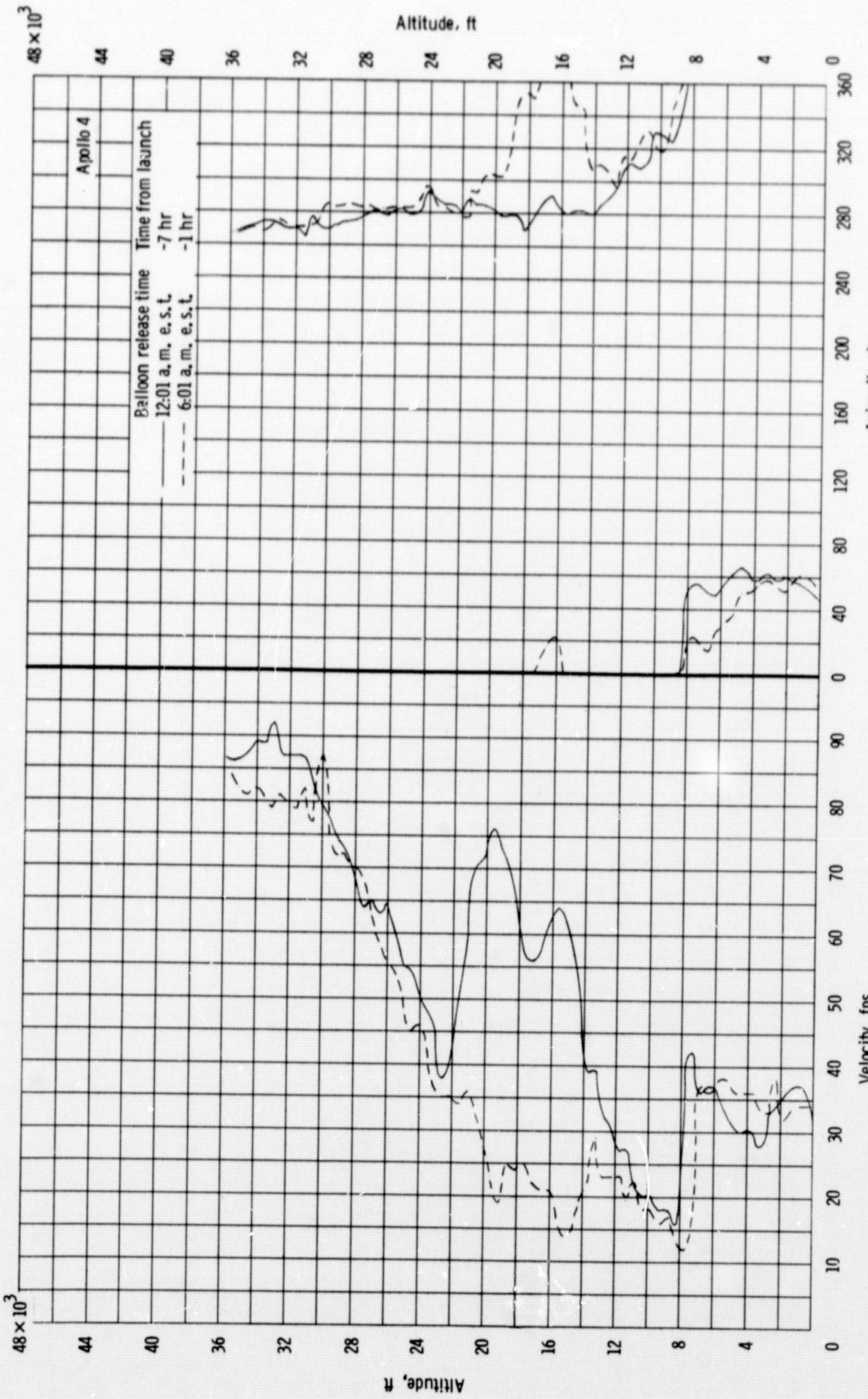

(a) AS-201 (February measured winds).

Figure 3. - Measured wind profile for the Apollo mission.




(b) AS-202 (August measured winds).

Figure 3. - Continued.




(c) Apollo 4 (November measured winds).

Figure 3. - Concluded.

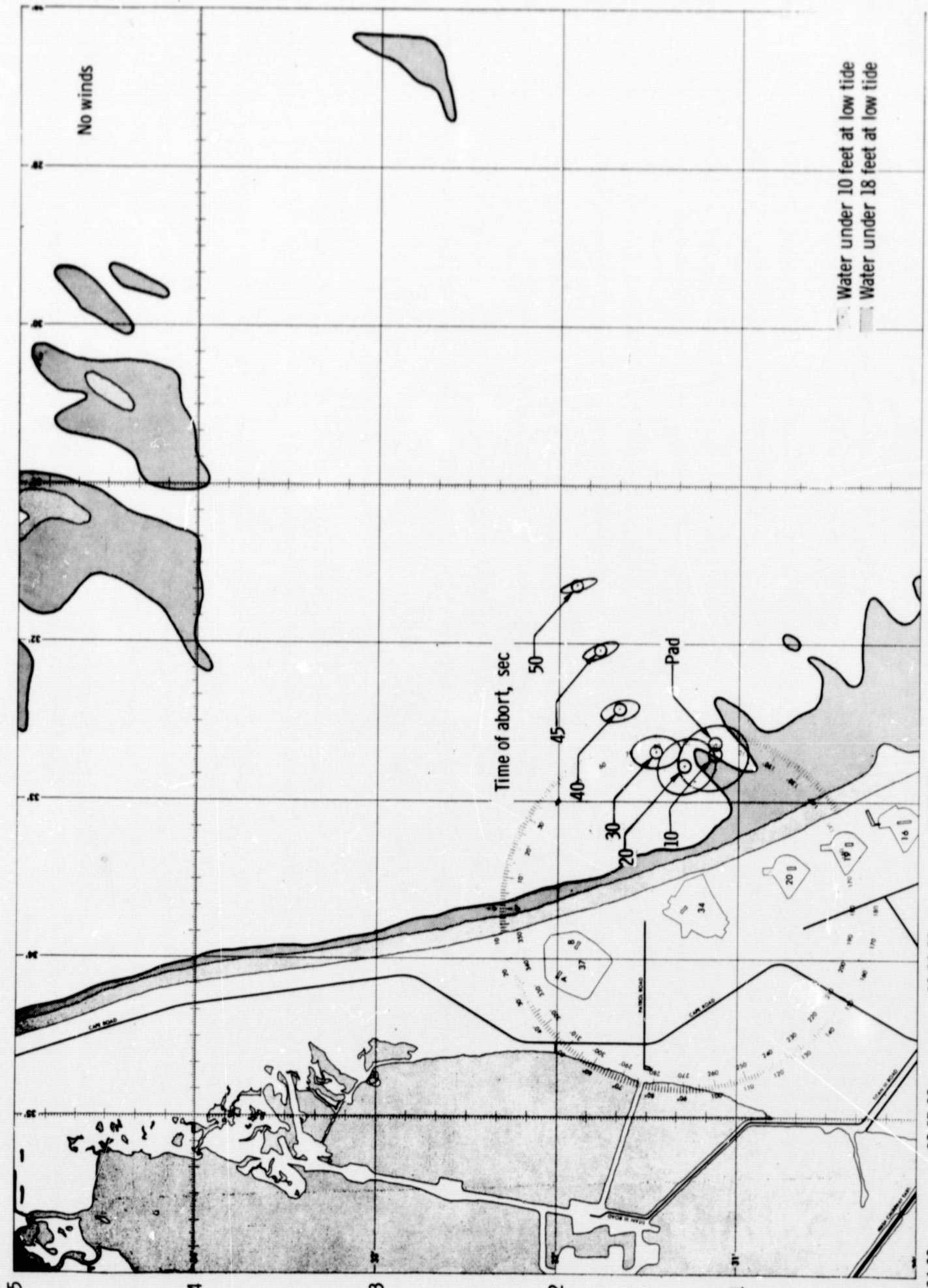
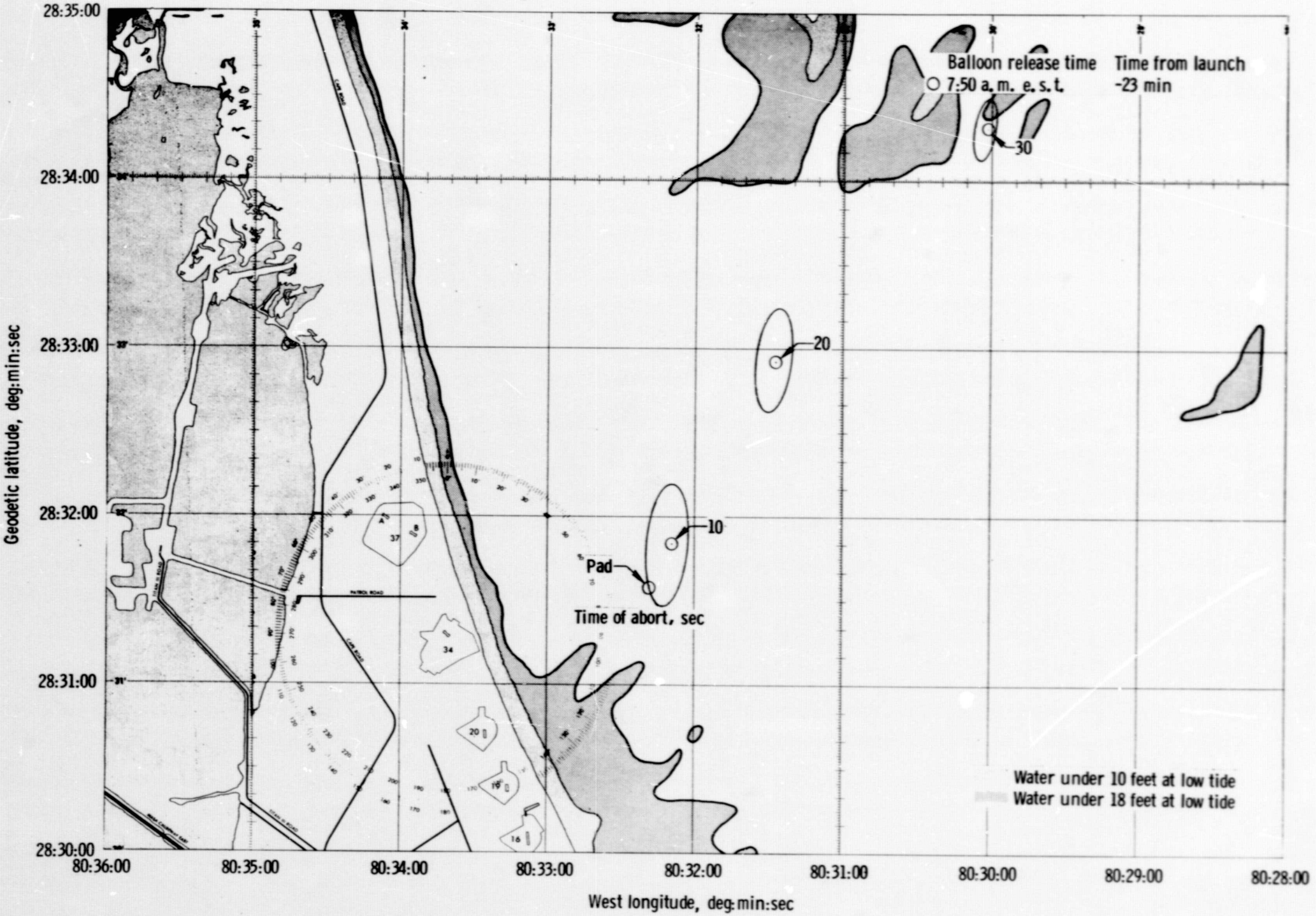
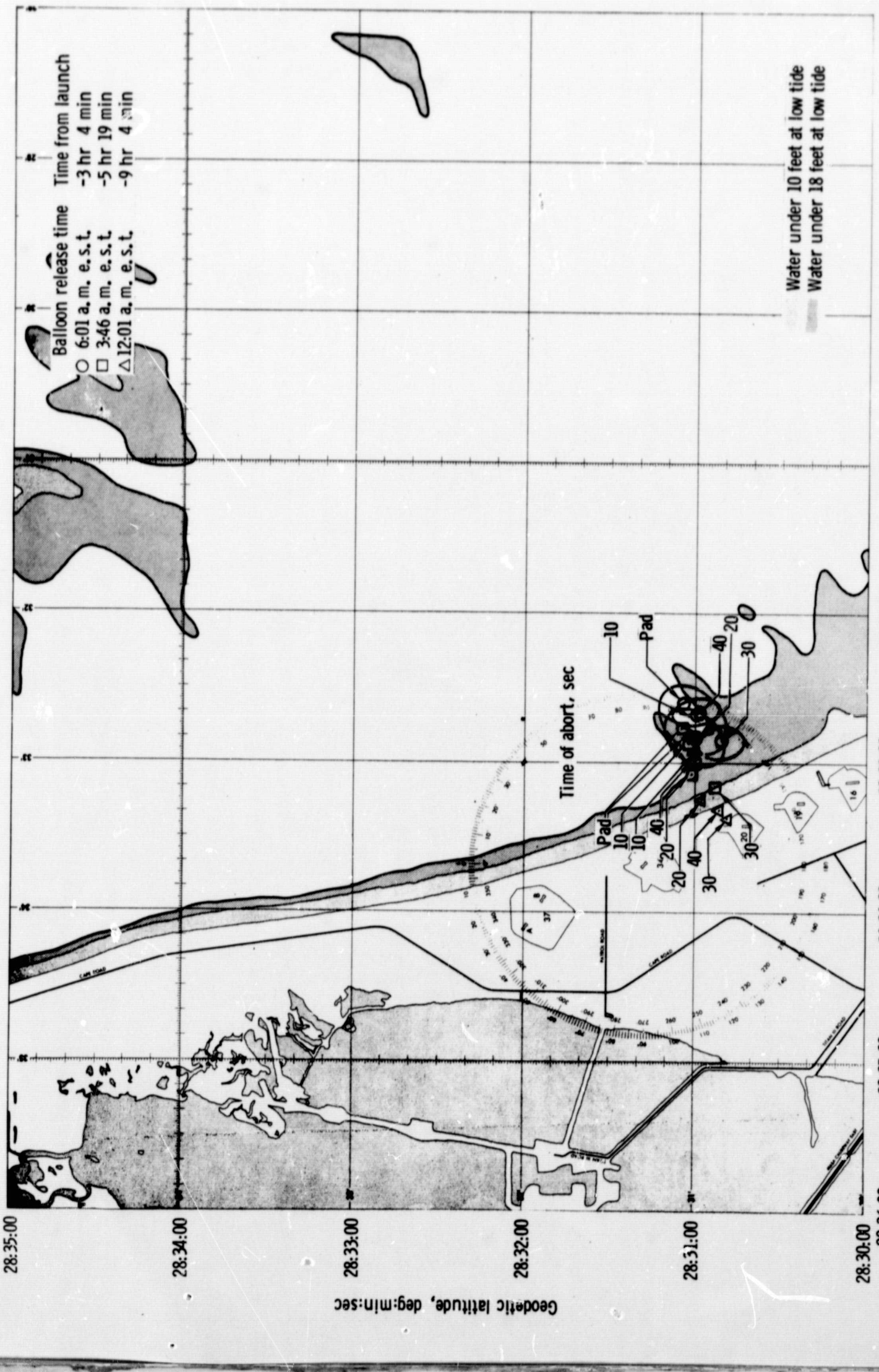



Figure 4. - Mode 1 (LEV) aborts - no winds.



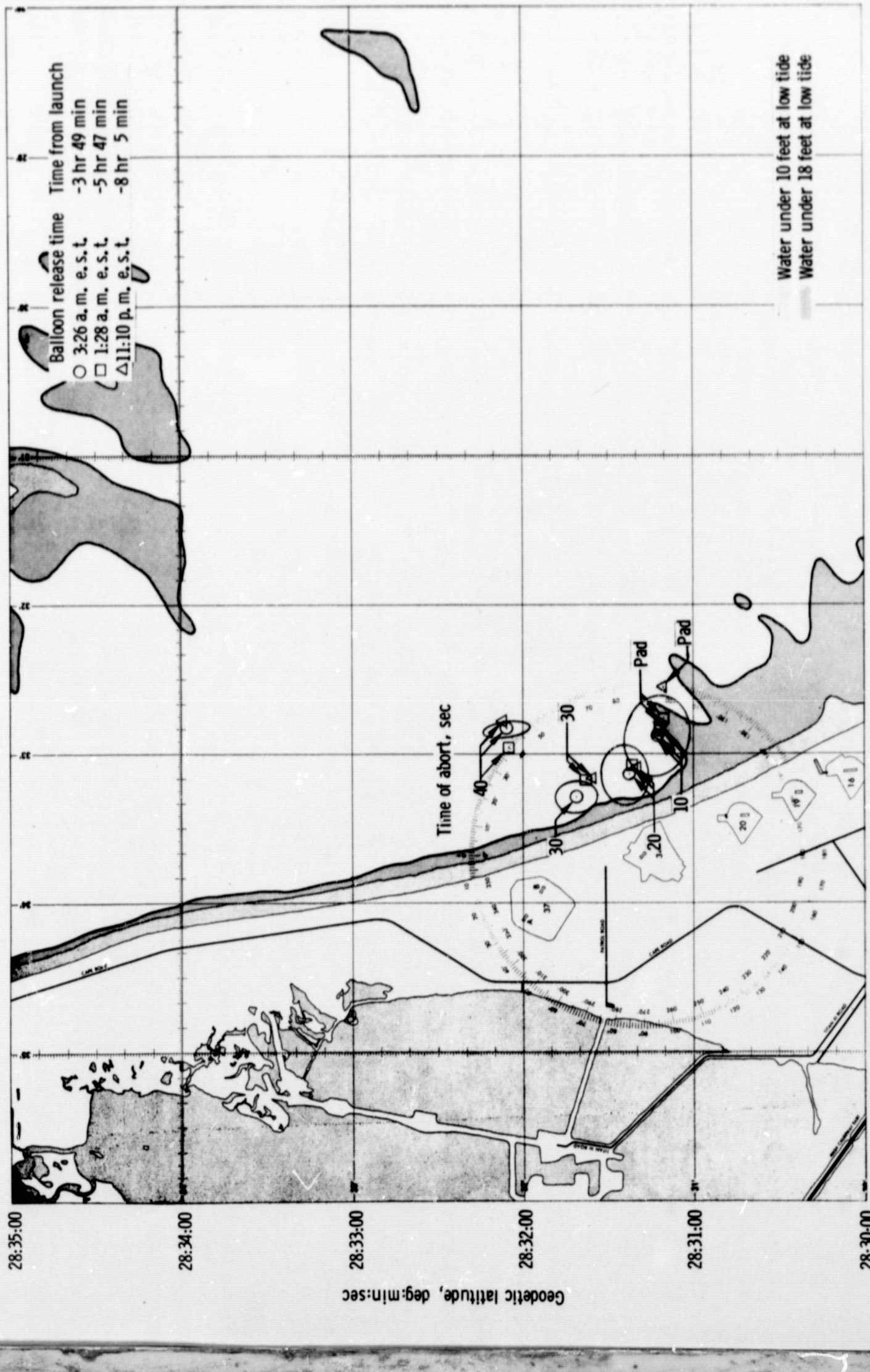

(a) MA-1 (July measured winds).

Figure 5. - Mode 1 (LEV) aborts using measured wind data from Mercury missions.



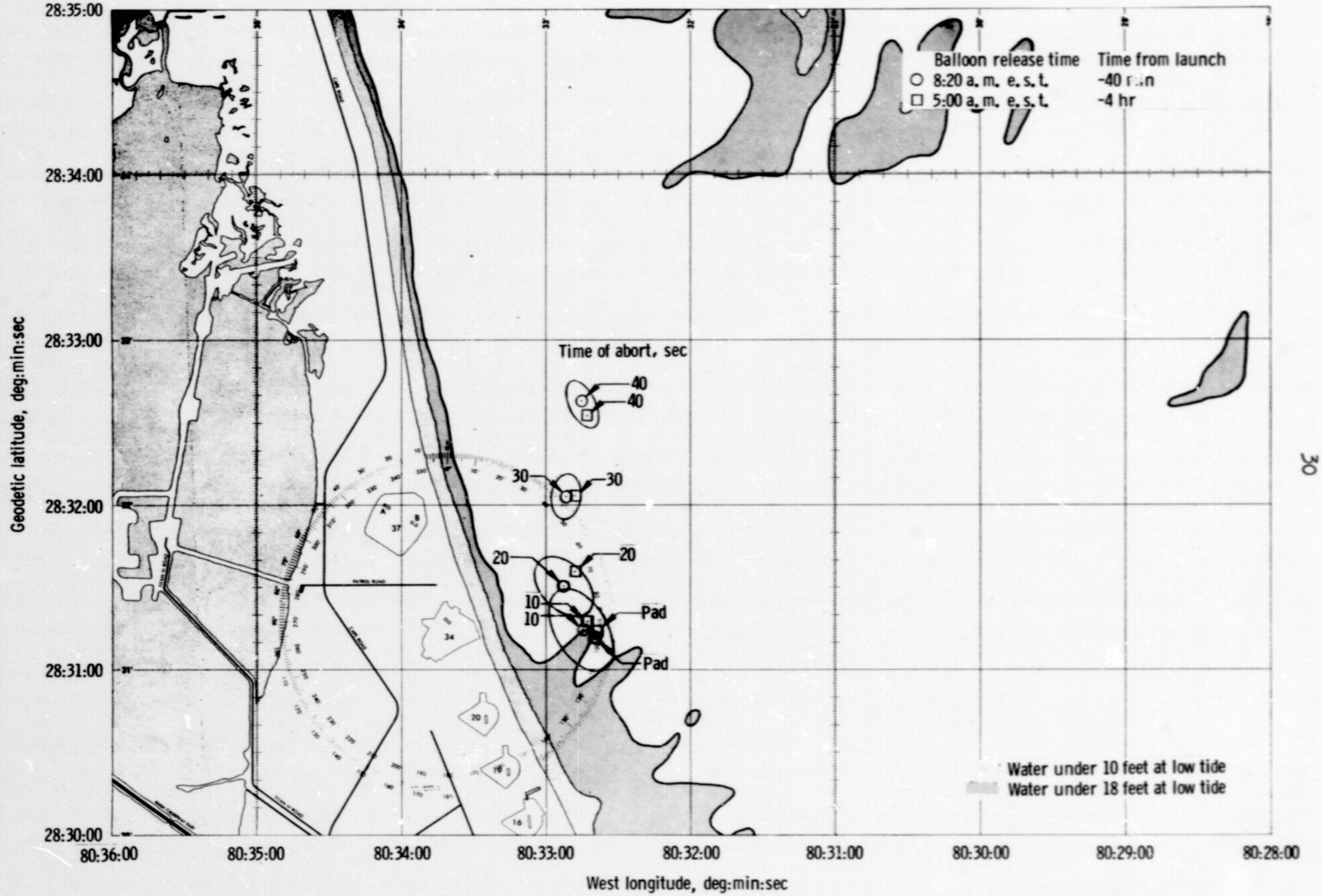

(b) MA-4 (September measured winds).

Figure 5.- Continued.



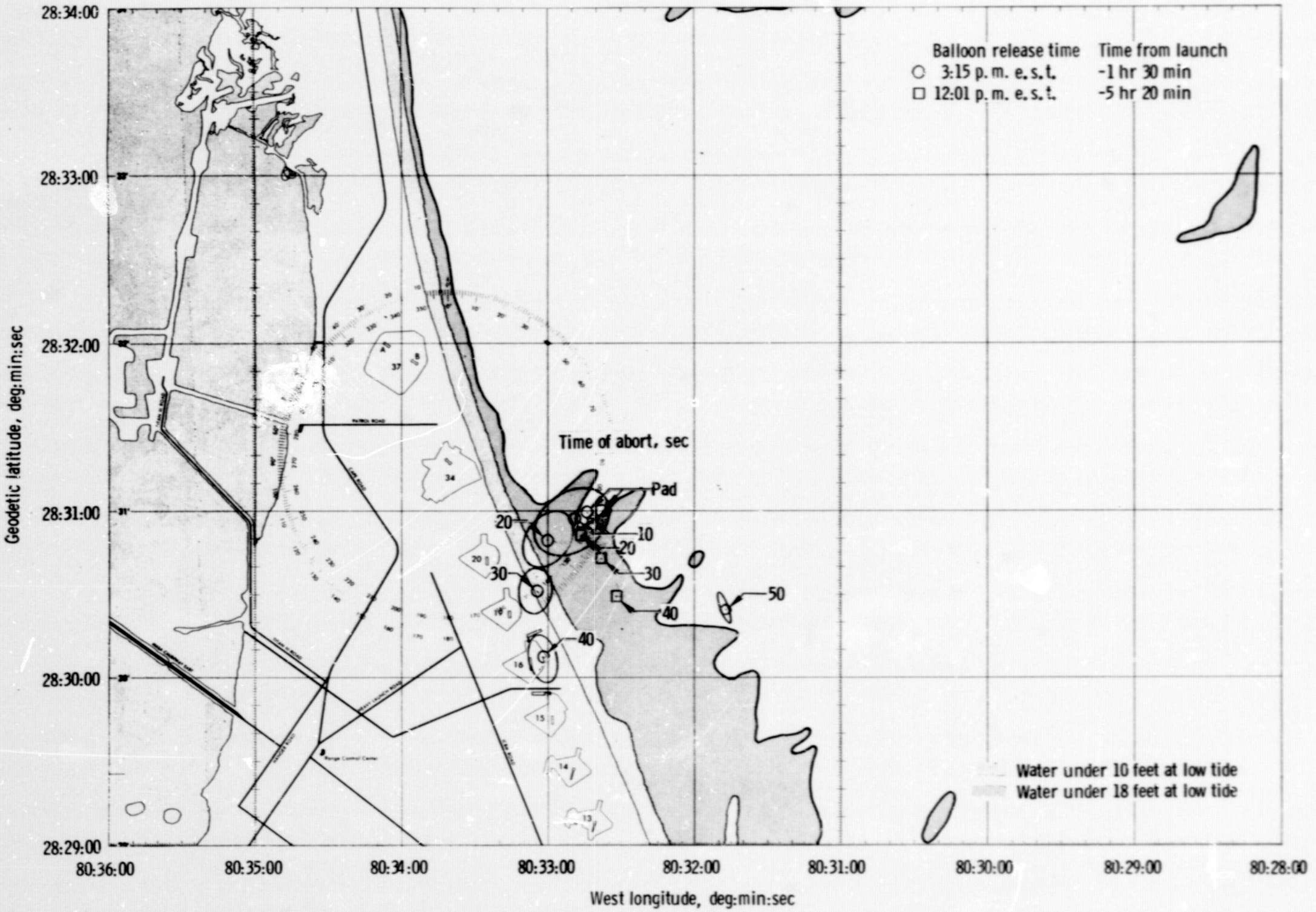

(c) MA-8 (October measured winds).

Figure 5. - Concluded.



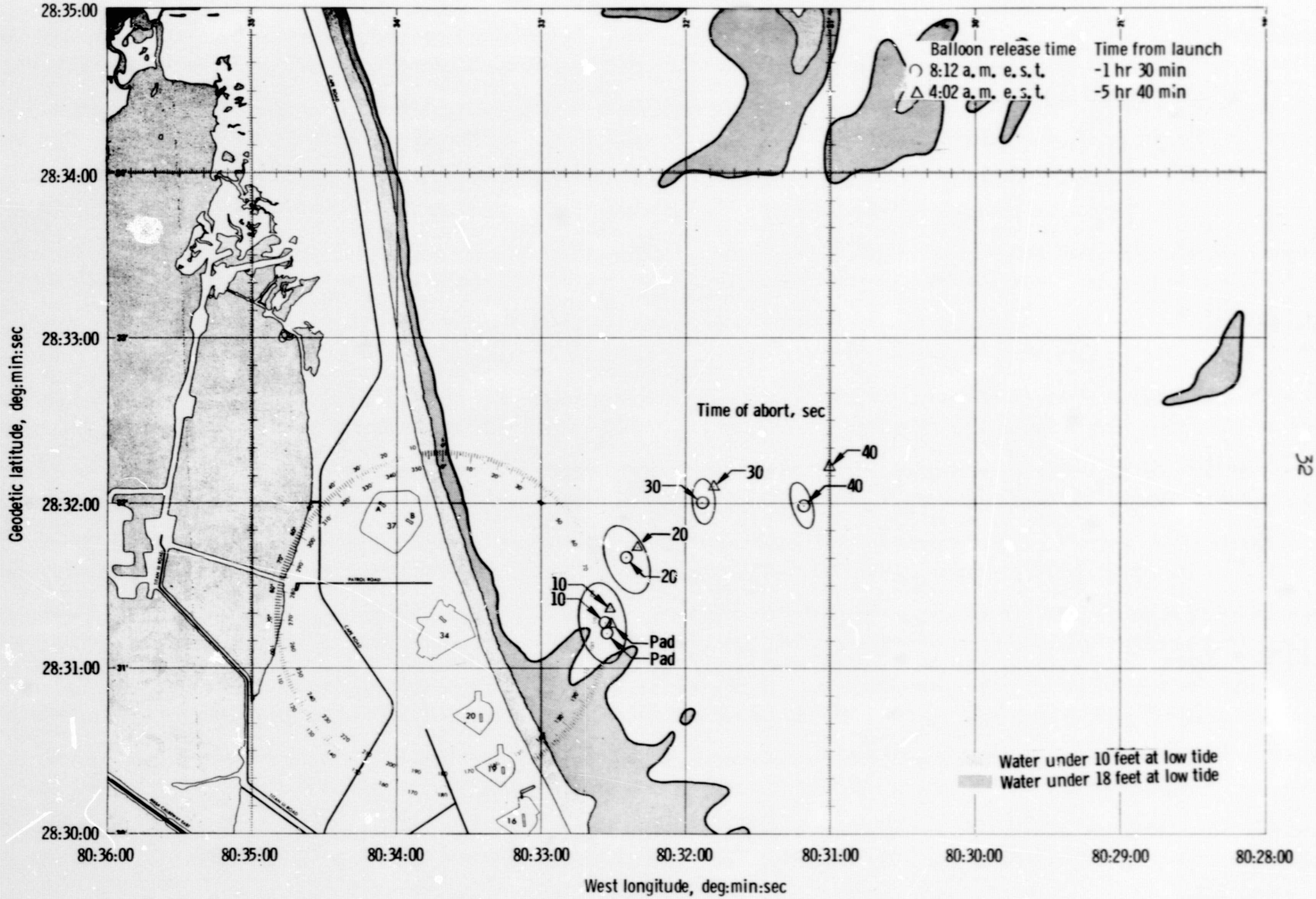

(a) GT-V (August measured winds).

Figure 6. - Mode 1 (LEV) aborts using measured wind data from Gemini missions.



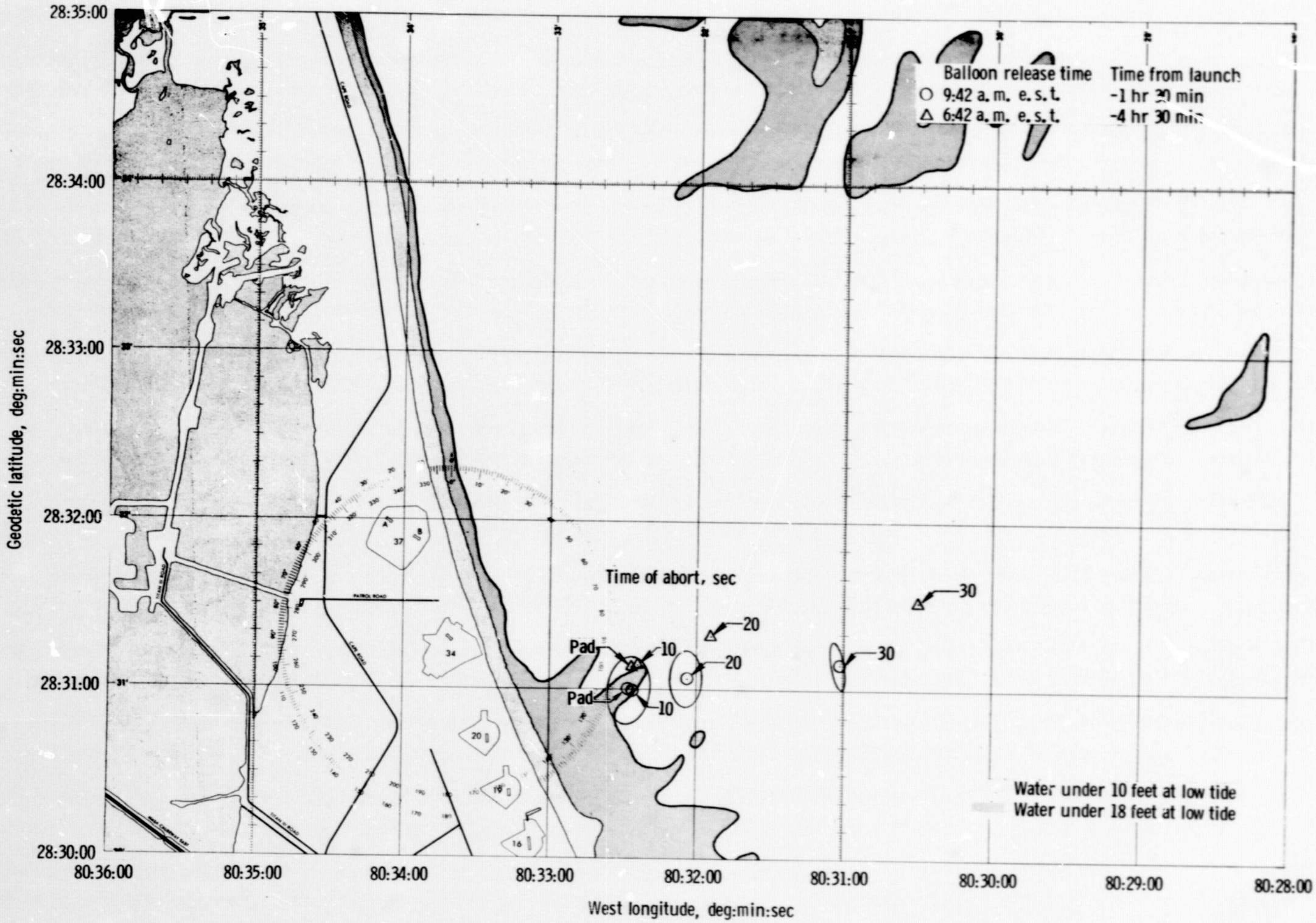

(b) GT-X (July measured winds).

Figure 6. - Continued.



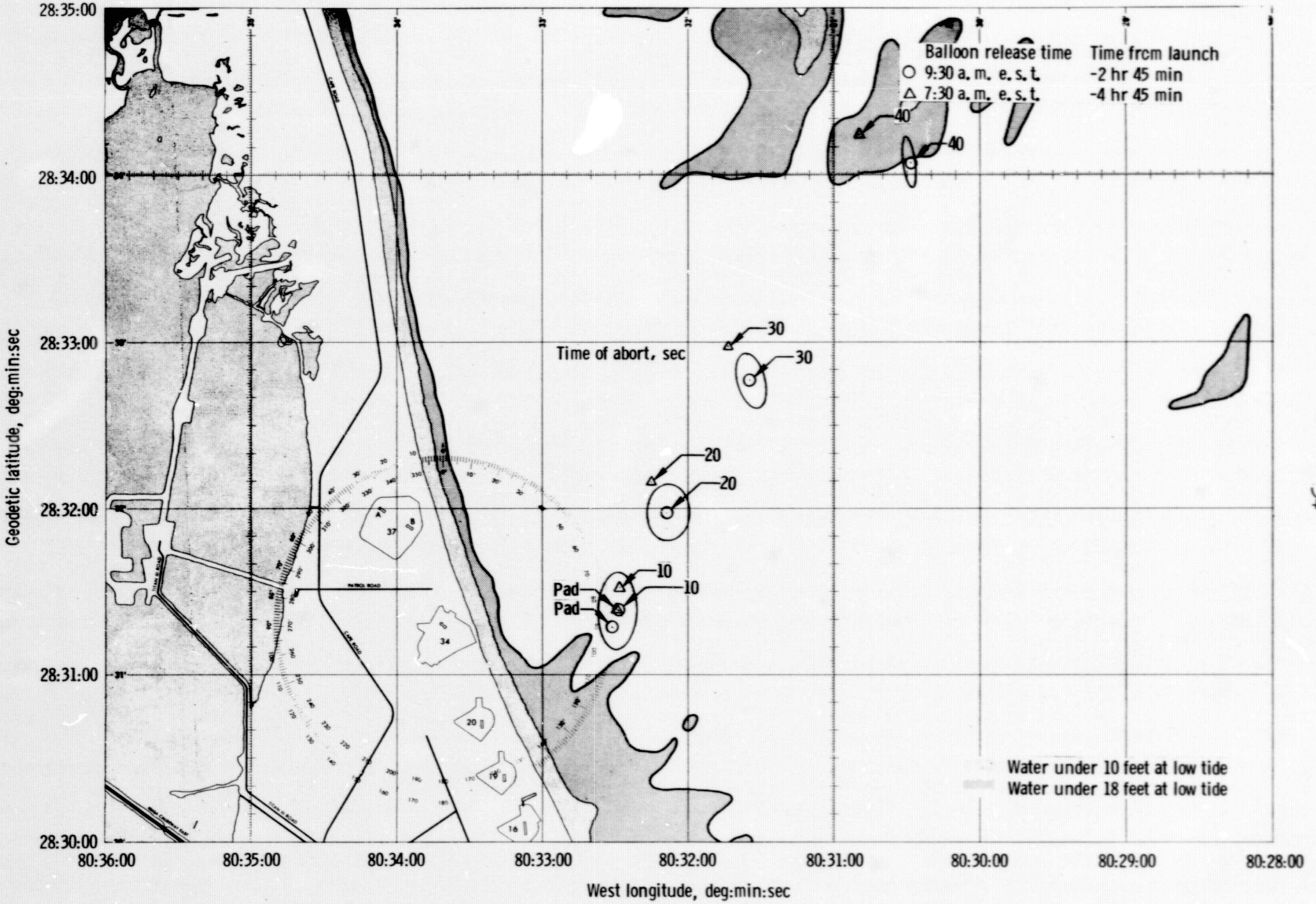

(c) GT-XI (September measured winds).

Figure 6. - Concluded.



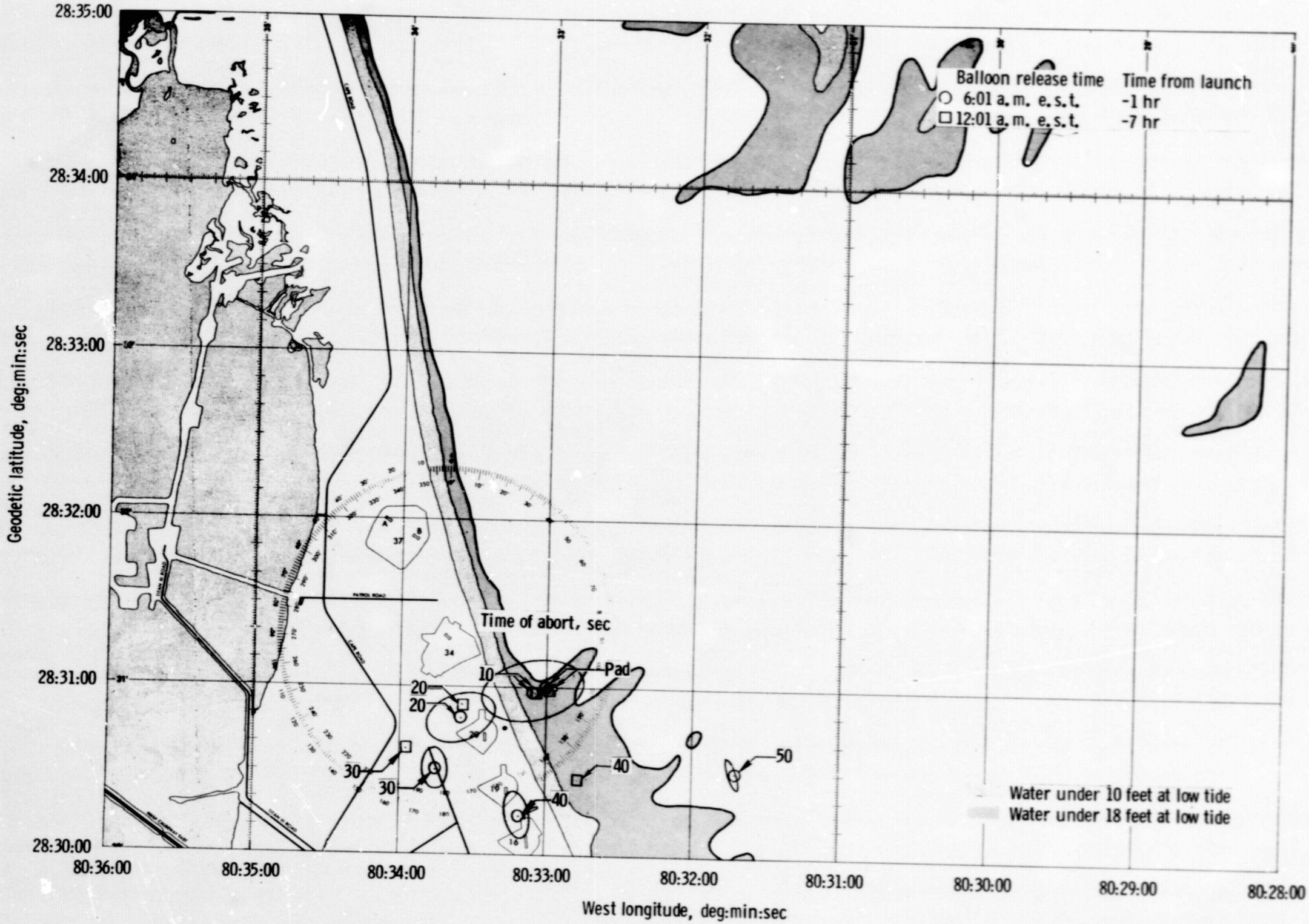

(a) AS-201 (February measured winds).

Figure 7. - Mode 1 (LEV) aborts using measured wind data from Apollo missions.



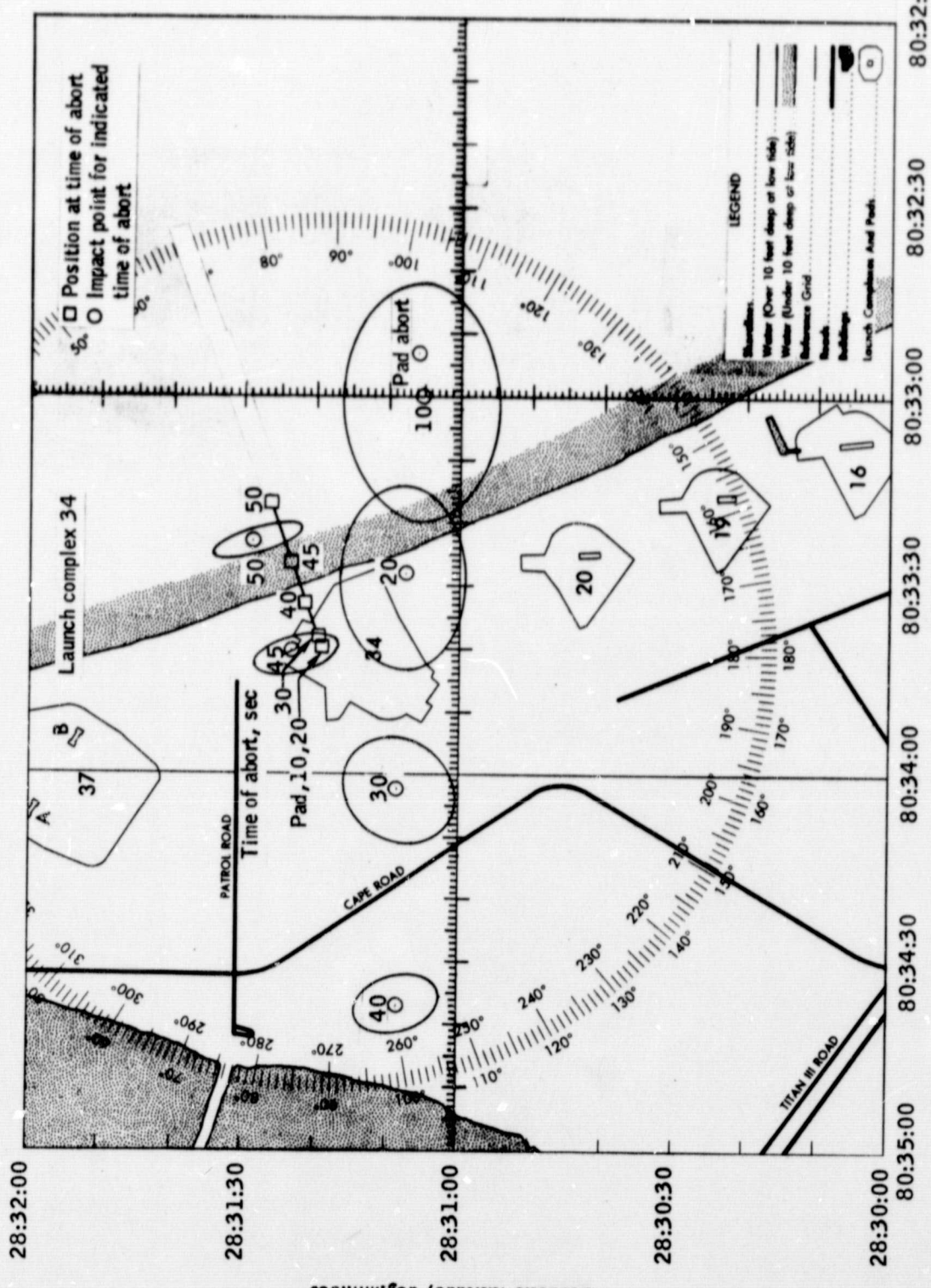

(b) AS-202 (August measured winds).

Figure 7. - Continued.



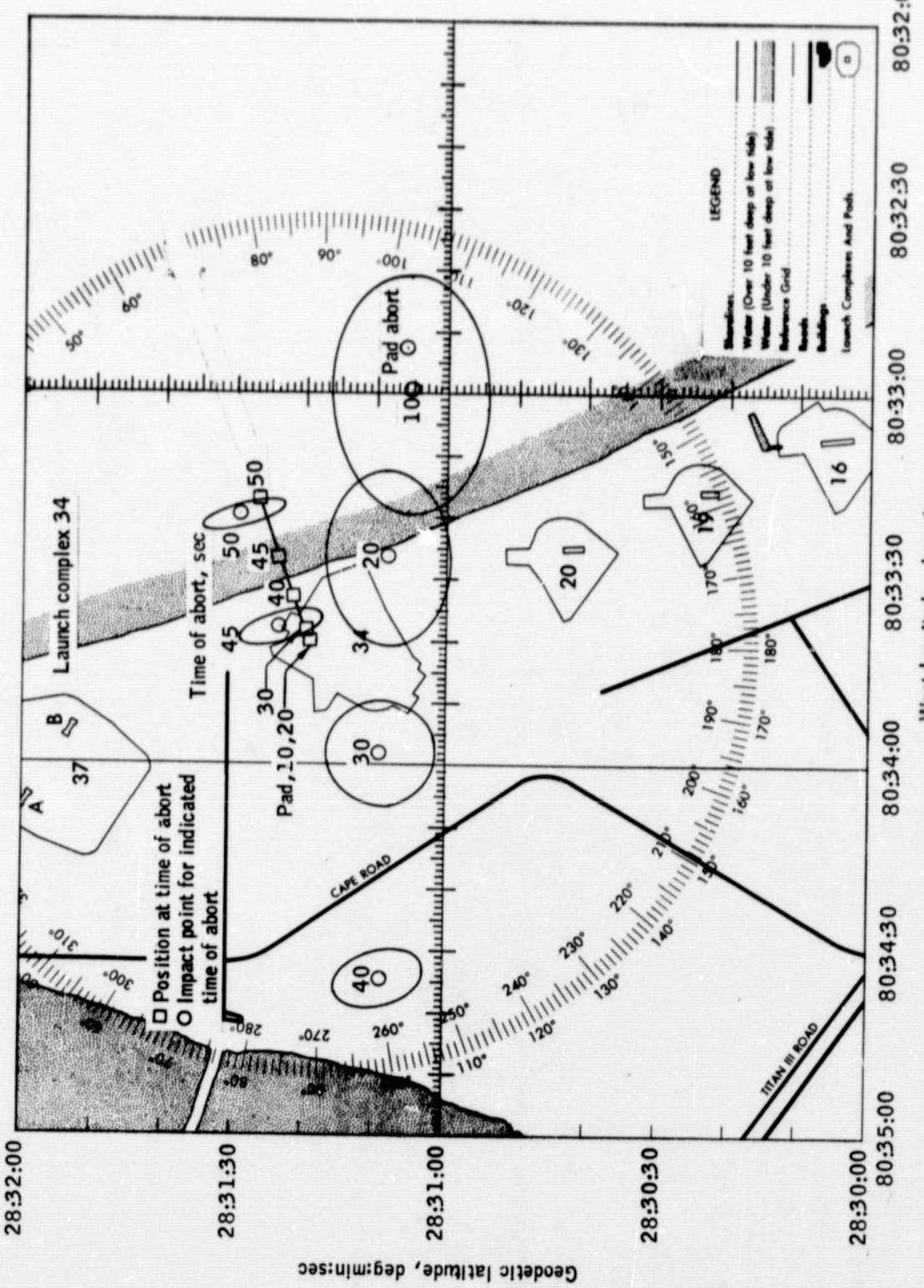

(c) Apollo 4 (November measured winds).

Figure 7. - Concluded.



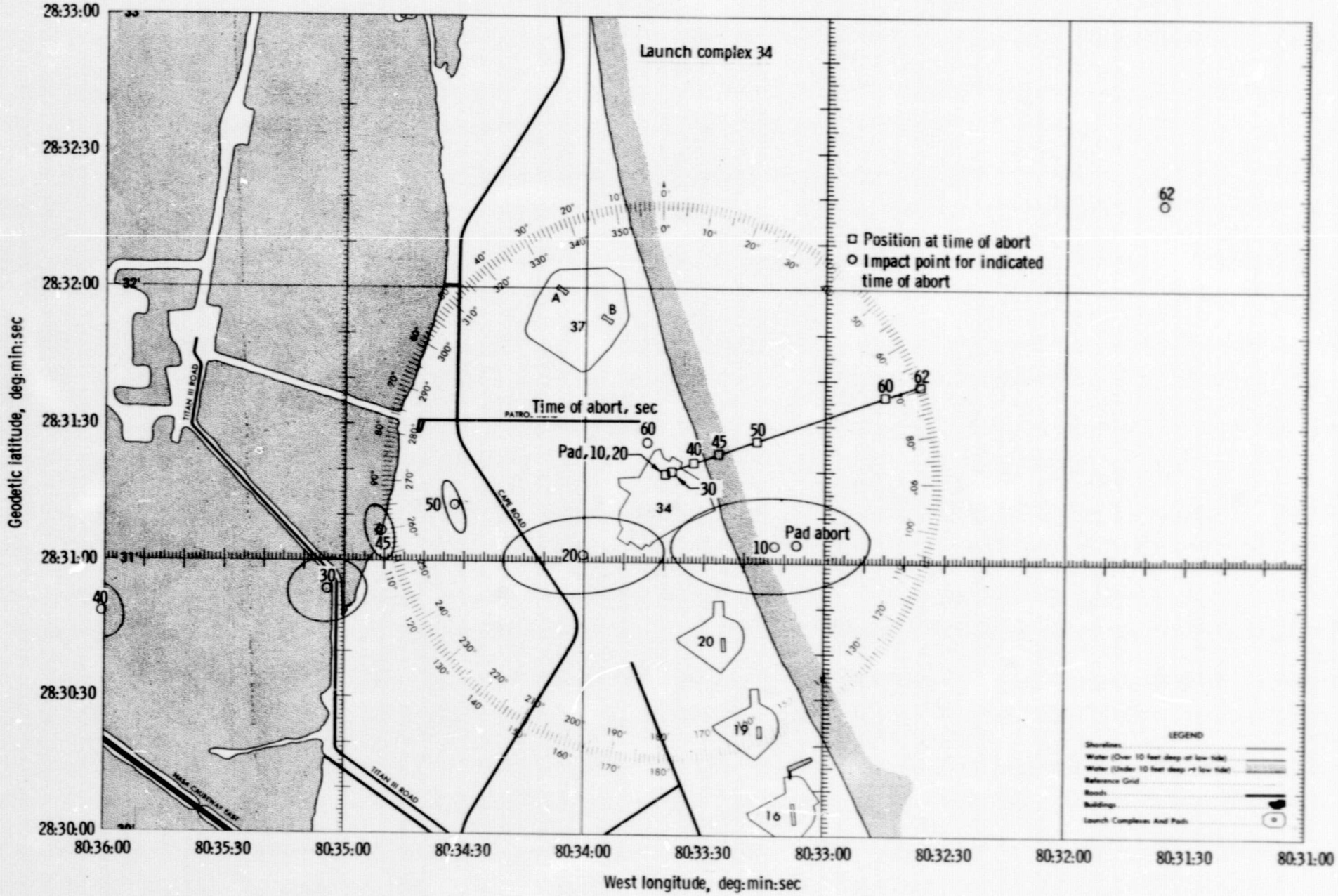

(a) July statistical winds.

Figure 8.- Mode 1 (LEV) aborts using statistical wind data.




(b) August statistical winds.

Figure 8.- Continued.




(c) September statistical winds.

Figure 8.- Concluded.

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11. Hischke, E. R.: Predicted Launch Abort Landing Point Data Computed during Apollo 4. MSC IN 68-FM-55, March 4, 1968.